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## 4.—The fungus *Panus fasciatus* (Pleurotaceae) characterised by microstructure of sporophore and culture

by Hung Ching Broughton\* and R. N. Hilton\*

Manuscript received 14 December, 1970; accepted 16 November, 1971

### Abstract

The techniques of hyphal analysis and growth on standardised media were used to compare three collections of *Panus fasciatus*, two from Western Australia and the other from New South Wales. Although the sporophores appeared similar macroscopically and microscopically, the cultures from Western Australia differed in growth rate, texture, colour and odour, from those of New South Wales, whilst being similar in their reaction to gallic and tannic acid incorporated in the media and in certain hyphal structures. They are considered to be different varieties of the same species. Another collection from New South Wales, named *Lentinus terrestris* Lloyd, is demonstrably different even at the generic level, although synonymy with *Panus fasciatus* had been suggested.

### Introduction

The taxonomy of the wood-attacking gill fungi, of which *Panus fasciatus* is an example, has been complicated by the ease with which they could be preserved as specimens by the early botanical collectors in various parts of the world. As these collectors did not realise the importance of collecting sporing specimens, and collecting them in sufficient quantity to represent developmental stages and phenotypic variation, numerous taxa have been erected on inadequate material poorly described. The object of the work reported here was to take several collections generally ascribable to *Panus fasciatus* and apply to them full micro-anatomical analysis, that might contribute to their taxonomy, supplementing this with equally exhaustive analysis of cultural characteristics. This combination of sporophore and culture analysis is seen as an essential in the elucidation of wood-attacking fungi (including the polypores) and, as this is the first time these tools have been applied to Western Australian collections, are reported in some detail. No attempt is made to make taxonomic decisions, which will depend on more extensive collections and comparisons with type specimens. However, the features that appear to be important in taxonomy are pointed out and it is shown that *Lentinus terrestris* Lloyd, considered by Cleland (1934 p 171) as probably synonymous with *Panus fasciatus*, must be a separate species on the basis of culture DFP 7396 and its corresponding sporophore.

### Methods

Fresh sporophores were described macroscopically and microscopically, colour descriptions being those of Ridgway (1912). Thin sections of sporophores were mounted in 10% potassium hydroxide containing 1% aqueous phloxine to stain the trama, hymenial layer

and hyphal elements. Melzer's Reagent was used to determine whether spores were amyloid or not.

Cultures were prepared from fresh sporophores and grown on 1.2% Malt Extract Agar as described by Nobles, 1965. Oxidase reactions with gallic and tannic acid were determined by Bavendamm's method as described by Davidson, Campbell and Blaisdell, 1938.

Cultures were examined microscopically after two weeks' incubation in the dark at 25°C, mounts of mycelium being from:—

(1) the advancing zone of the colony, (2) the aerial mycelium at a point one week's growth behind the margin, (3) submerged mycelium below point (2), (4) aerial mycelium at the point of two weeks' growth behind the margin, (5) submerged mycelium at the same point as (4).

Colour descriptions of hyphae and spores were made from water mounts without heat treatment. Mounts for measurements and detailed microscopic analysis were made in 10% potassium hydroxide and 1% phloxine, as used for sporophore material.

### Description of *Panus fasciatus* (Berk.) Pegler from Western Australia

Culture WW1 was isolated from sporophores growing on decayed wood collected in Tutaning Reserve, Western Australia, August 1966 UWA. Mycology Herbarium number 1250. Specimens sent to the Royal Botanic Gardens Kew, were determined by Mr. D. N. Pegler as *P. fasciatus* (Berk.) Pegler, a fungus collected in Tasmania and described by Berkeley as *Lentinus fasciatus* (Pegler, 1965).

Culture XX1 was isolated from an identical fungus collected from a fallen dead trunk of *Eucalyptus marginata*, Karnet, Western Australia, August 1966. UWA Mycology Herbarium number 1260.

### Sporophores

Sporophores tough when fresh, hard when dried. Pilei deeply infundibuliform, densely hispid with involute margins, Clay to Tawny Olive, diameter 1.2-3 cm. Gills deeply decurrent, crowded, entire along the edge, tinged pale purple when fresh but Light Mouse Gray when dried. Stipes, central, 1.0-2.5 cm, densely hispid and brown (Fig. 1).

Pileus with filamentous cuticle and white context. Dimitic: skeletal hyphae mainly in the trama (Fig. 2B) and hyaline, thick-walled, septate, clamped, and occasionally branched, with narrow lumen, 3 — 5  $\mu$  wide, mean 3  $\pm$  0.1  $\mu$ . In contrast, generative hyphae thin-walled and,

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Figure 1.—*Panus fasciatus* from Western Australia. Sporophores corresponding to culture number XX1.

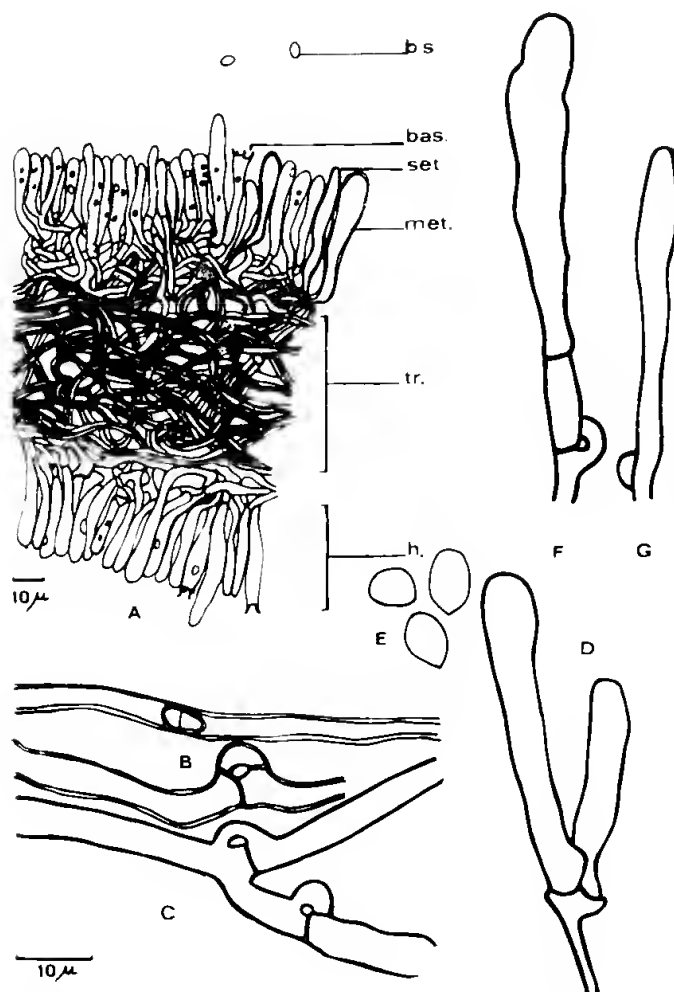


Figure 2.—*Panus fasciatus* from Western Australia. Detail from sporophore corresponding to culture number XX1. A—Vertical section through gill showing irregular trama (tr) indistinct subhymenium, and a hymenium (h) consisting of clavate basidia (bas.), "metuloids" (met.) and "setae" (set.); basidiospores (b.s.). B—Skeletal hyphae. C—Generative hypha. D—Immature basidia. E—Basidiospores. F—Metuloid. G—Thin-walled "seta".

2—4  $\mu$ , mean  $2 \pm 0.1 \mu$ , and frequently branched (Fig. 2C). Trama irregular and inamyloid, subhymenium indistinct, hymenium of basidia and cystidia (Fig. 2A). Most of the basidia observed in sections were immature (Fig. 2D). Fertile basidia clavate and  $20 - 36 \times 4 - 7 \mu$ , mean  $27 \pm 0.1 \times 6 \pm 0.1 \mu$ . Basidiospores hyaline, inamyloid and oblong, with smooth walls, and  $4 - 7 \times 3 - 5 \mu$ , mean  $5 \pm 0.2 \times 3 \pm 0.1 \mu$  (Fig. 2E). Cystidia originated from tramal hyphae and could be differentiated into two main types. In the first type, the cystidia were few and scattered, had thick walls and obtuse apices. They could be described as metuloids, except for the lack of crystals on their surfaces. They measured  $24 - 43 \times 5 - 7 \mu$  mean  $33 \pm 2 \times 6 \pm 0.2 \mu$  (Fig. 2F). In the second type, the cystidia were similar in size but differed in shape and wall thickness. They were thin-walled, had acute apices and were quite numerous, slightly proliferating above the hymenial surface (Fig. 2G). They resembled setae except for their thinner walls.

#### Cultures: macroscopic

Both isolates had indented margins consisting of appressed and submerged mycelium. The rest of the mycelial mat was raised-woolly with small aggregates of mycelium appearing near and over the inoculum after two to three weeks of growth (Figs. 3, 5). The aggregates grew larger (Figs. 4, 6), and from subsequent development were found to have been fruiting body primordia. Plates were covered after three weeks' incubation. Colour developed after four weeks: Cream Buff, then Pinkish Cinnamon, deepening to Cinnamon Buff after exposure to light. The primordia were of purplish tinge, turning to brown when exposed to light. The reverse side of the mycelial mat changed slightly to Cream Buff, particularly under the intermediate zone and inoculum. Growth rate at  $25^\circ$  was the same in both isolates: 2.0-2.9 cm/wk, mean  $\pm 0.1$ . Reactions on tannic and gallic acid were strong with unsatisfactory growth of both isolates.

#### Cultures: microscopic

All hyphae examined were hyaline with thin walls or with thick refractive walls that stained poorly in phloxine. The advancing zone, aerial mycelium and submerged mycelium shared some hyphae in common. These were either thin-walled hyphae, clamped and occasionally branched (Fig. 7, a1 and a2, e1 and e2), or were wide, conspicuously clamped, with fairly thick, refractive walls characteristically branched from three clamp connections (Fig. 7, d2 and f1).

(1) *Advancing zone* (Fig. 7, a1-d2).—Two principal types of hyphae were found in the advancing zone of both isolates, XX1 and WW1. They were: (i) Long, thin-walled, hyaline hyphae with "eyelet" type of clamp connections, 4-5  $\mu$ , characteristically branched near a clamp connection and forming another clamp near the point of origin of the side branch; occasional in both isolates, (Fig. 1, a1 and a2). (ii) Thin-walled, hyaline hyphae, clamped and frequently branched, branches usually short and produced in close proximity to each other, 2-4  $\mu$  wide; occasional in both isolates (Fig. 7, b1 and b2).

In addition, two more hyphal types were observed in cultures of isolate WW1. These were:— (iii) Long, thin-walled hyphae, clamped, 3-4  $\mu$  wide, with short side branches slightly naviculate in shape; rare, and arranged in a parallel fashion in the advancing zone (Fig. 7, c2). (iv) Large, thin-walled hyphae, 5-6  $\mu$  in diameter, with conspicuous clamp connections and characteristically producing branches from three clamp connections (Fig. 1, d2); rare.

(2) *Aerial mycelium* (Fig. 7, e1-j2).—The aerial mycelium in both isolates, XX1 and WW1, possessed five main types of hyphae, two of which were similar to those in the advancing zone (Fig. 7, e1, e2, f1, f2, compared with a1, a2 and d2). The other hyphal types were:— (i) Long, narrow hyphae with highly refractive walls, bearing small clamp connections and branched, either opposite to a clamp connection or near to a clamp, but more often simple branches were found (Fig. 7, g1-g2). In isolate WW1 only, this type of hypha occasionally was found to produce structures resembling chlamydospores (Fig. 7, h2), but, unlike true chlamydospores, they were not divided from the parent

hypha by a septum near the base. (ii) Narrow, thick-walled hyphae, 1-2  $\mu$  wide, with lumen almost obliterated, frequently branched, resembling fibre hyphae but, unlike them, having small clamp connections, rare in XX1, occasional in WW1 (Fig. 7, i1 and i2). Clamp connections of the "eyelet" type were abundant in cultures of both isolates. Branching of the simple type was frequently found in XX1 but occasionally in WW1, where branching near a clamp connection on the parent hypha and producing another clamp near the origin of the side branch, was slightly more frequent (Fig. 7, j1 and j2). Hyphal diameter 1-5  $\mu$  mean  $3 \pm 0.2 \mu$  for both isolates.

(3) *Submerged mycelium* (Fig. 7, k1-m2).—Hyphae in this area were more intensively branched than in the other areas. Three types were recognised, two of which had been found in the advancing zone and aerial mycelium (Fig. 7, k1, k2 and l1, l2). The third type of hypha was narrow, 1-3  $\mu$  wide, thin-walled and septate, with clamp connections and numerous short side branches often slightly hooked at the tips (Fig. 7, m1 and m2). The

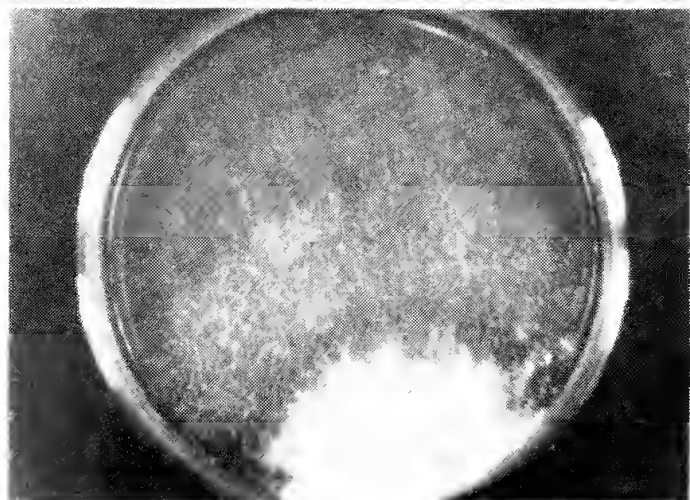


Figure 3 (above).—*Panus fasciatus* from Western Australia. Culture number XX1 two weeks old, showing uneven margin and a raised woolly texture on the mycelial mat. Mycelial mat white.

Figure 4 (below).—*Panus fasciatus* from Western Australia. Culture number XX1 four weeks old, showing that mycelium near and over the inoculum has become very dense. Fruit body primordia have developed near to the inoculum. Mycelial mat now cream buff and pinkish cinnamon.

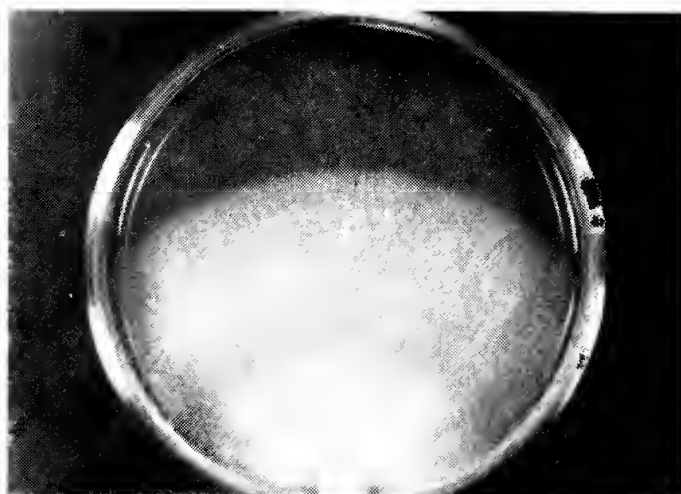


Figure 5 (above).—*Panus fasciatus* from Western Australia. Culture number WW1 two weeks old showing essentially the same features as XX1. (cf. Figure 3).

Figure 6 (below).—*Panus fasciatus* from Western Australia. Culture number WW1 after four weeks. Still showing features similar to XX1 (cf. Figure 4).



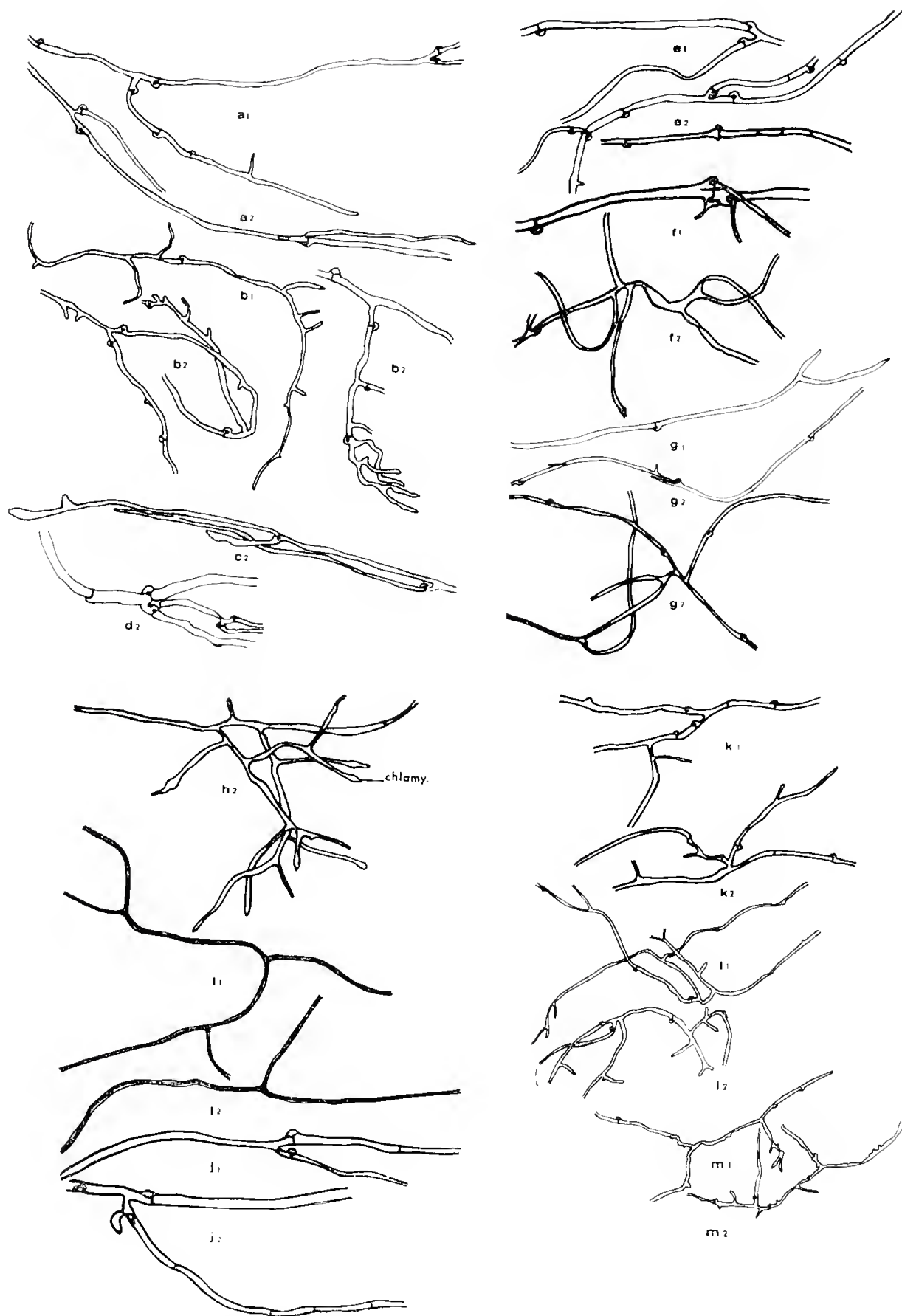


Figure 7.—*Panus fasciatus* from Western Australia. Culture numbers XX1 and WW1. Details of hyphae from advancing, aerial, and submerged mycelium. Subscript 1 refers to XX1 and subscript 2 refers to WW1.

Advancing zone, a1-d2: b1-b2, hyphae with branches produced in close proximity; c2, hyphae with short side branches slightly naviculate in shape; d2, wide hyphae with conspicuous clamp connections characteristically branched at three clamp connections. Aerial Mycelium, e1-j2: f2, hyphae irregularly enlarged; g1-g2, hyphae with highly refractive walls; h2, hyphae with terminal swellings resembling chlamydospores (chlamy.) except for the absence of a septum; i2, thick-walled "fibre hyphae". Submerged mycelium, k1-m2: m1-m2, hyphae with short lateral branches straight or slightly hooked at the tips.

Table 1

Comparison of sporophore microstructure of *Panus fasciatus* and *Lentinus terrestris*

	<i>P. fasciatus</i> (W.A.)		<i>P. fasciatus</i> (N.S.W.)		<i>L. terrestris</i> (N.S.W.)	
	Range	Mean	Range	Mean	Range	Mean
Basidia	20-36 × 4-7	27 ± 0.1 × 6 ± 0.1	22-54 × 4-7	31 ± 1.8 × 6 ± 0.2	18-40 × 4-9	29 ± 1.2 × 6 ± 0.3
Basidiospores	4-7 × 3-5	5 ± 0.2 × 3 ± 0.1	4-7 × 3-5	6 ± 0.1 × 4 ± 0.1	5-9 × 4-5	6 ± 0.5 × 4 ± 0.2
Skeletal hyphae	3-5	3 ± 0.1	2-5	2 ± 0.2	3-5	4 ± 0.2
Generative hyphae	2-4	2 ± 0.1	2-4	3 ± 0.1	2-4	3 ± 0.1
Metuloids	24-43 × 5-7	33 ± 2 × 6 ± 0.2	22-36 × 4-7	31 ± 0.7	Nil	Nil

All measurements in  $\mu$ .

"eyclet" type of clamp connection was abundant in the submerged mycelium of both isolates. Hyphal diameter 1-6  $\mu$ , mean  $3 \pm 0.2 \mu$  for both isolates.

#### Comparison of *Panus fasciatus* from Western Australia and New South Wales

Specimens of *Panus fasciatus* from Nambucca Heads, New South Wales, (DFP 5365) showed

strong resemblances to those from Western Australia in the macro- and micro-features of the sporophores. They both had brown, densely hispid, deeply infundibuliform pilei; decurrent gills with entire edges; brown, hispid stipes (Fig. 1 and 8). Microscopically they were similar in having a white context, filamentous cuticle, and an irregular, inamyloid trama consisting of skeletal and generative hyphae. The subhymenium was indistinct in both specimens and the hymenium consisted of essentially the same elements. These were clavate basidia; oblong, hyaline, smooth, basidiospores; metuloids and setae. There was a slight difference in size of these elements between the two specimens (Table 1), and the setae from the New South Wales specimen had thicker walls (Fig. 9, f). Cultures from New South Wales did show differences in texture, colour, odour and growth rate from the Western Australian isolates, although reactions on gallic and tannic acid media



Figure 8.—*Panus fasciatus* from New South Wales. Sporophore corresponding to culture number DFP 5365. Note growth from a pseudosclerotium.

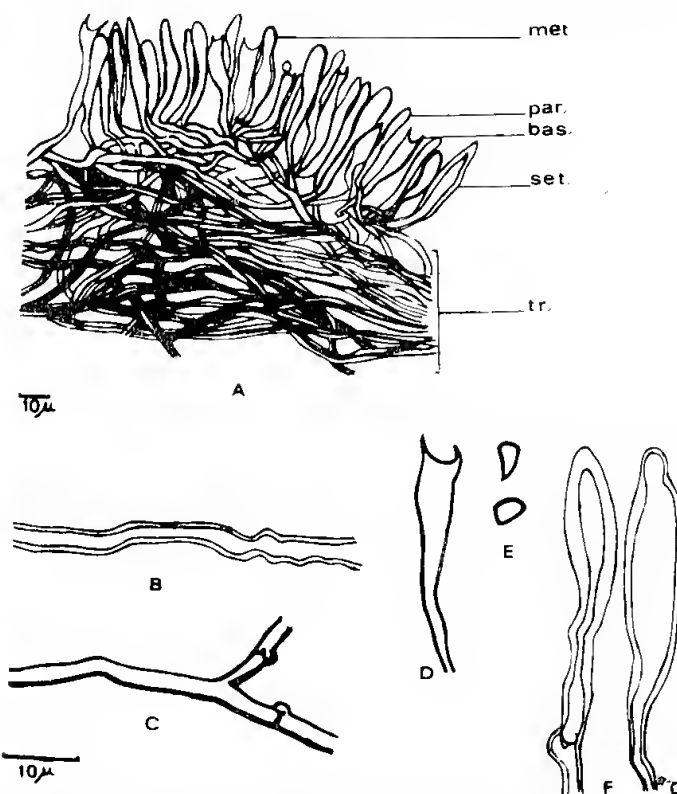


Figure 9.—*Panus fasciatus* from New South Wales. Detail from sporophore corresponding to culture number DFP 5365. A.—Vertical section through gill, showing irregular trama (tr.), basidia (bas.) paraphysate hyphae (par.) metuloids (met.) and setae (set.). B.—Skeletal hypha. C.—Generative hypha. D.—Basidium. E.—Basidiospores. F.—"Seta". G.—"Metuloid".

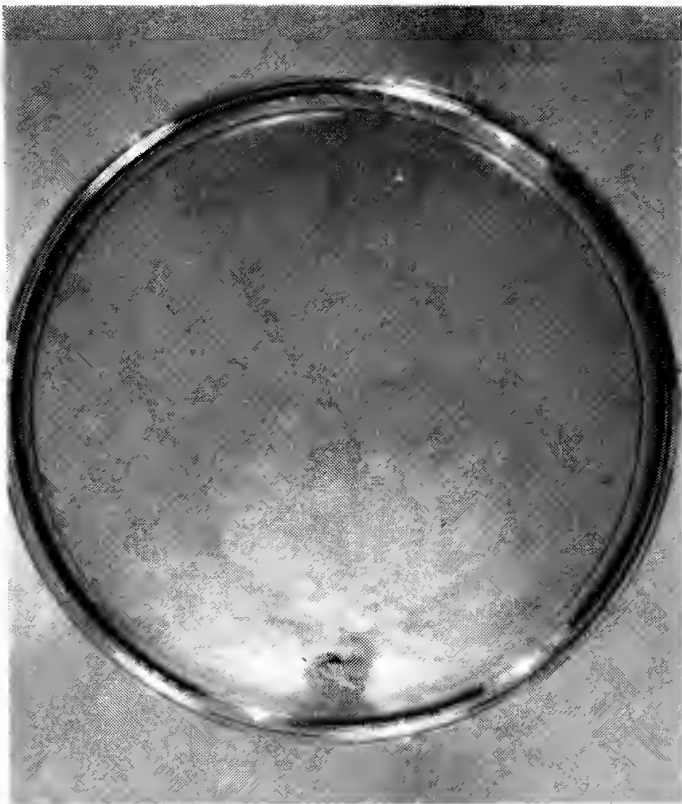


Figure 10 (above).—*Panus fasciatus* from New South Wales. Culture DFP 5365 two weeks old with a raised, silky texture in the younger parts and a sub-felty texture in the older parts of the mycelial mat, which was maize yellow or cream-buff in colour.

Figure 11 (below).—*Panus fasciatus* from New South Wales. Culture DFP 5365 after four weeks, showing little change except for the development of small compact lumps of mycelium over the inoculum.

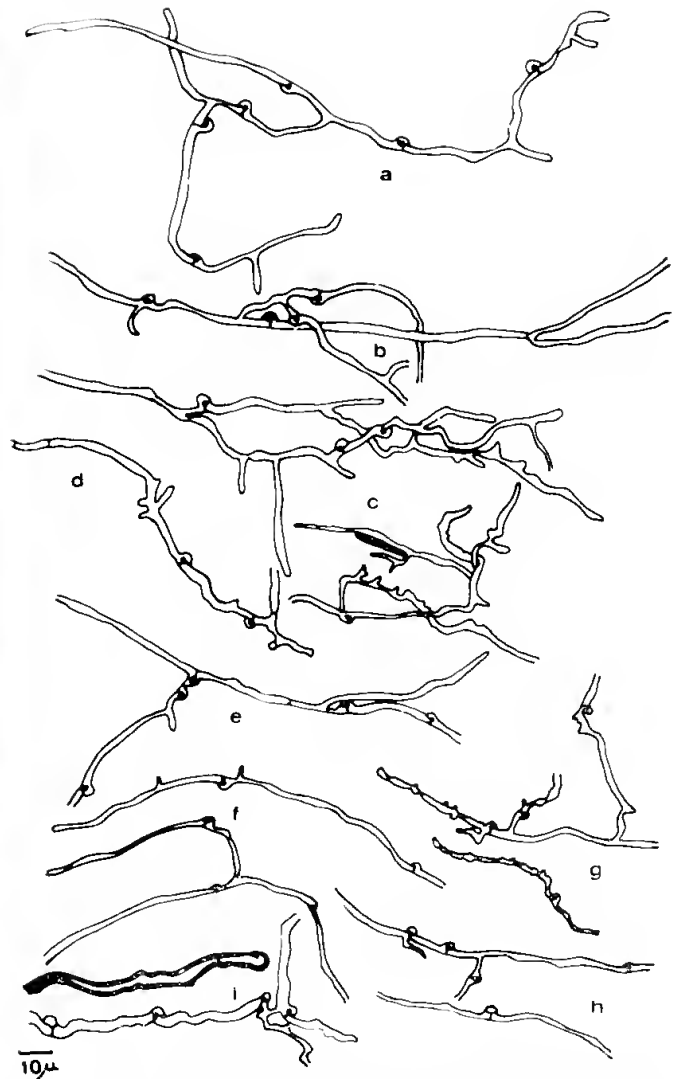


Figure 12.—*Panus fasciatus* from New South Wales. Culture number DFP 5365. a-c, hyphae from the advancing zone; d-f, from the aerial mycelium; g-i, from the submerged mycelium.

were similar. In spite of the differences in the macroscopic appearance of the cultures (Figs. 10 and 11), two hyphal structures were found to be identical between the two isolates (Fig. 12, a, was similar to Fig. 7, a1 and a2, while Fig. 12, c and g resembled Fig. 7, m1 and m2). It can be concluded that the *Panus fasciatus* from New South Wales was the same species as that from Western Australia, but a different variety.

#### Comparison of *Lentinus terrestris* with *Panus fasciatus* from Western Australia

Cleland (1934 p. 171) suggested *Lentinus terrestris* Lloyd (1925) as a probable synonym of *Panus fasciatus* (quoted by him as *L. fasciatus* Fr.). Because of Cleland's suggestion, supported by co-types in his possession, named specimens of *L. terrestris* were obtained from the Division of Forest Products, C.S.I.R.O., Melbourne for comparison with specimens of *Panus fasciatus* from Western Australia. The collection supplied was DFP 7396 collected on Mount Banda Banda, Wauchope, N.S.W., September, 1959.

*Lentinus terrestris* showed differences from *Panus fasciatus* in the macro- and micro-features of the sporophores and in the macro-





Figure 13.—*Lentinus terrestris* Lloyd. Sporophores corresponding to culture number DFP 7396.

scopic and microscopic appearance of the cultures.

Morphologically, *L. terrestris* differed from *P. fasciatus* in having pilei that were slightly depressed at the centres, gills that were dentate instead of entire, and large sporophores that were also hispid but with shorter abhymenial hairs. *L. terrestris* grew from a pseudo-sclerotium in soil. (Fig. 1 and Fig. 13).

Microscopically (Fig. 14) both sporophores appeared similar but unlike *P. fasciatus*, the trama in *L. terrestris* was subregular (Fig. 14, A), although it was also composed of inamyloid, thick-walled skeletal hyphae. Generative and skeletal hyphae appeared similar in both species and were of similar size (Table 1). The subhymenium was indistinct and the hymenium was composed of essentially the same elements in both species. These were clavate-shaped basidia; hyaline, inamyloid, smooth basidiospores, and setae. However, unlike *P. fasciatus*, *L. terrestris* had no metuloids. Basidia and basidiospores were larger in *L. terrestris* (Table 1) and the setae in *L. terrestris* had uniformly thick walls and were not thin-walled as in *P. fasciatus* from Western Australia.

Cultures of *L. terrestris* (Fig. 15 and 16) differed in texture, colour and growth rate from cultures of *P. fasciatus*. *L. terrestris* had a cottony mycelial mat which became woolly during later periods of incubation. *P. fasciatus* had a woolly texture throughout the whole period of incubation, with the mycelium becoming slightly appressed as the cultures grew older. Growth rate in *L. terrestris* was slower. The mycelial mat was Pale Pinkish Buff, Pinkish Buff or

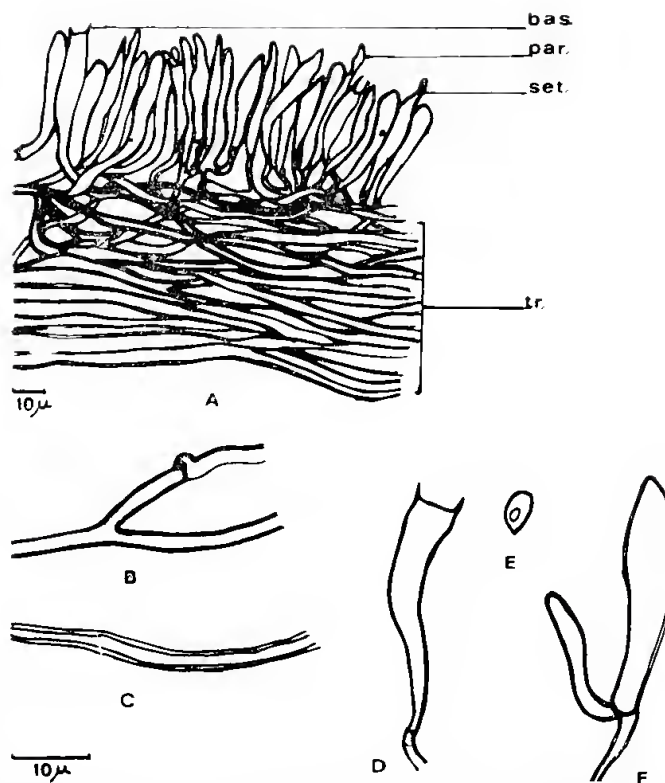


Figure 14.—*Lentinus terrestris* Lloyd. Sporophore corresponding to culture number DFP 7396. A—Vertical section through gill showed subregular trama (tr.) in distinct subhymenium and hymenium consisting of clavate-shaped basidia (bas.) setae (set.) and paraphysate hyphae (par.) Note absence of metuloids. B—Generative hypha, thin-walled, clamped and branched similar to those of *P. fasciatus*. C—Skeletal hypha, thick-walled and rarely branched, resembling those of *P. fasciatus*. D—Clavate basidium, larger than *P. fasciatus*. E—Basidiospores similar to those of *P. fasciatus* except for the larger size. F—Seta, thick-walled.

Light Ochraceous Salmon in *L. terrestris* whereas it was Cream Buff or Pinkish Cinnamon in *P. fasciatus*. Reactions on tannic and gallic acid media differed from *P. fasciatus* only in that on gallic acid being weak.

Microscopically, the hyphae in cultures of *L. terrestris* differed from *P. fasciatus* in the absence of clamp connections (Fig. 17 compared with Fig. 7), the presence of dendritic hyphae (Fig. 17, c) and in having true chlamydospores in the aerial and submerged mycelium in *L. terrestris* (Fig. 17, 1, compare with Fig. 7, h2).

The general characters of the *L. terrestris* isolate, particularly the inamyloid spores and toothed gills, are consistent with its being retained in the genus *Lentinus*, differing from *P. fasciatus* even at this, the generic, level.

#### Acknowledgements

The work described in this paper was conducted during the tenure by Mrs. H. C. Broughton of a University of Western Australia Postgraduate Award. Thanks are due to Mr. E. W. B. DaCosta and Mr. N. E. M. Walters for supplying the New South Wales specimens of *Lentinus terrestris* and *Panus fasciatus* and for helpful discussion during visits to their laboratory in the Division of Forest Products, C.S.I.R.O., Melbourne. Identification of the Western Australian specimen of *Panus fasciatus* from Tutaning was kindly provided by the Royal Botanic Gardens, Kew.

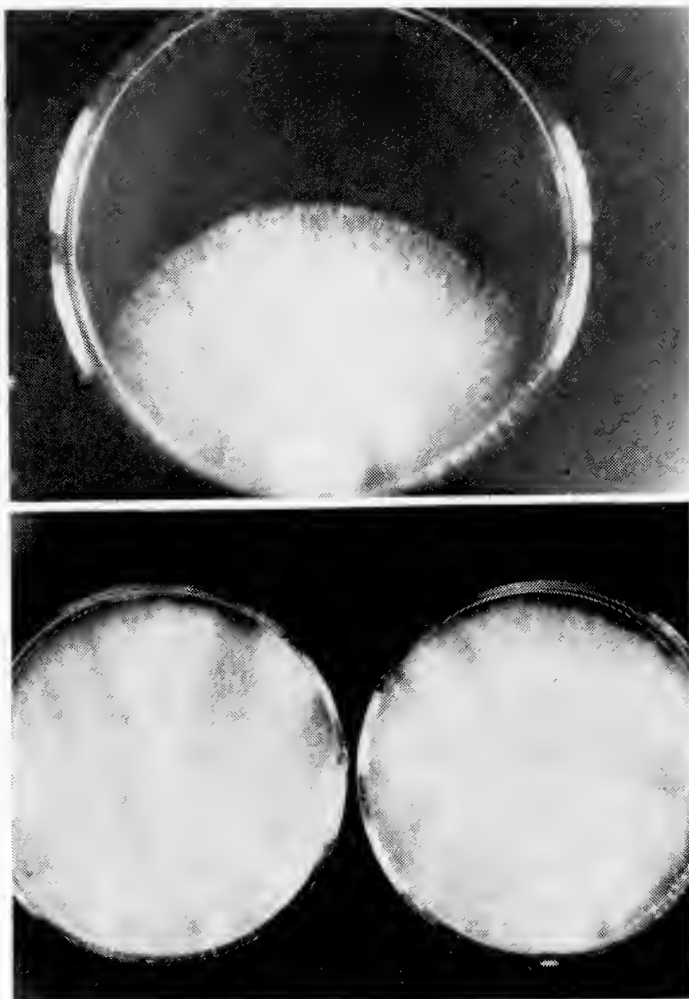


Figure 15 (above).—*Lentinus terrestris* Lloyd. Culture DFP 7396 two weeks old, showing white aerial mycelium, uneven margin and raised cottony-woolly texture.

Figure 16 (below).—*Lentinus terrestris* Lloyd. Culture DFP 7396 four weeks old, showing zones and radial striations on the mycelial mat. Colour developed over the inoculum, but no fruiting bodies even after exposure to light.

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Figure 17.—*Lentinus terrestris* Lloyd. Culture number DFP 7396. a-d, hyphae from the advancing zone; e-h, hyphae from the aerial mycelium; i-k, hyphae from the submerged mycelium; a, hyphae intensively branched; c and f, dendritic hyphae, observed in *L. terrestris* only; d, hyphae with highly refractive walls, and numerous short side branches; m-p, crystals.

## 5.—A new species of the genus *Ramphotyphlops* (Serpentes: Typhlopidae) from Western Australia

by J. Robb\*

Communicated by G. M. Storr

Manuscript received and accepted 22 February 1972

### Abstract

A new species of *Ramphotyphlops* from Western Australia is described, and named *R. leptosoma*. The new species is shown to most closely resemble *R. minimus*, but to be distinguished from it by a number of characters.

### Introduction

In September 1967 Mr. R. B. Humphries collected two specimens of *Ramphotyphlops* at "The Loop", lower Murchison River, Western Australia. The snakes were given to Dr. G. M. Storr of the Western Australian Museum at Perth, who kindly sent them to me for examination. The specimens, one male and one female, proved to be of a previously unrecognised species, and is named and described below.

### *Ramphotyphlops leptosoma* new species

**Holotype:** R 29623 (male); "The Loop", lower Murchison River, Western Australia; 3rd September 1967; collected by Mr. Robert B. Humphries.

**Paratype:** R 29624 (female); same data as holotype.

**Diagnosis:** A small, thin-bodied snake of the genus *Ramphotyphlops* having:

- (1) 16 scale rows at mid-body;
- (2) 660 to 665 dorsal scales;
- (3) prominent snout, with obtusely angular horizontal edge;
- (4) inferior nostrils;
- (5) complete nasal cleft;
- (6) pale coloration throughout with little contrasting darker markings.

**Description of species:** Total length 250 to 282 mm; tail 4.5 times as long as broad in the male, and 2.5 times as long as broad in the female; diameter at mid-body 3.5 mm; dorsal scales (from rostral to terminal spine) 665 in the male, and 660 in the female; spine on tip of tail conical; 16 longitudinal rows of scales at all points posterior to head; four upper labials, first smallest and fourth largest; rostral very large, extending almost to the level of the eyes, rounded posteriorly, the portion visible from below broader than long, almost reaching nostril, concave at mouth edge; eye visible beneath

translucent ocular and preocular scales; preocular narrower than nasal or ocular, partly overlying eye anteriorly, its lower border in contact with second and third upper labials; ocular large, bordered above by supraocular and parietal, and posteriorly by two unmodified body scales, lower edge of ocular in contact with third and fourth upper labials; supraocular and parietal larger than unmodified dorsal scales; frontal smaller than unmodified dorsal scales; nasal divided by nasal cleft into small antero-ventral portion and large postero-dorsal portion; antero-ventral nasal in contact with first and second upper labials; postero-dorsal nasal extending on to top of snout between rostral anteriorly and preocular and supraocular posteriorly, in contact with prefrontal dorsally; nasal cleft extending from lower border of nasal, in contact with second upper labial, through nostril, to meet lateral border of rostral on ventral surface; snout prominent, with obtusely angular horizontal edge, forming a ridge; nostrils inferior; five lower labials, the first and third smallest, fourth and fifth largest.

Colour generally pale throughout, dorsal surface pale grey/brown, undersurface grey/white.

**Range:** Known only from the Murchison River area, Western Australia.

**Relationships:** In characters of bodily scalation and proportions *R. leptosoma* most closely resembles *R. minimus*; these being the only two Australian species so far described with 16 mid-body scale rows, and small, slender bodies. The two are distinguishable from each other on the basis of the shape of the snout (angular in *leptosoma*, blunt in *minimus*); size of the rostral (smaller in *leptosoma* than *minimus*); the disposition of the nasal cleft (which reaches the rostral in *leptosoma* but not in *minimus*), and the colour (fairly uniformly pale in *leptosoma*, while *minimus* has an almost black head and tail or tail only, and yellowish brown body distinctly marked with dark longitudinal lines).

### Acknowledgement

I wish to offer my sincere thanks to Dr. G. M. Storr, of the Western Australian Museum for allowing me the privilege of examining and describing these specimens.

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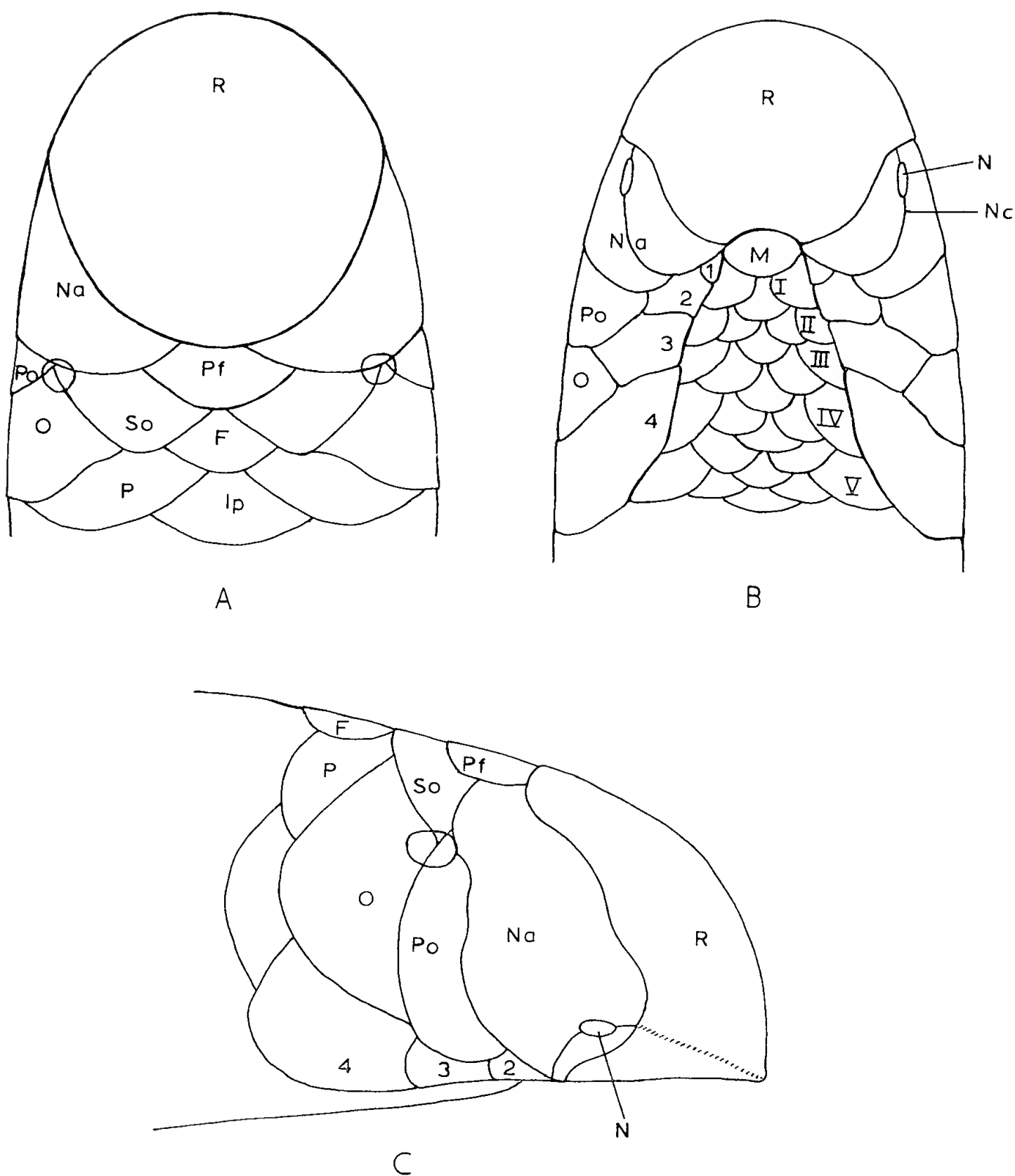


Figure 1.—Head of *Ramphotyphlops leptosoma* new species. A.—Dorsal view. B.—Ventral view. C.—Lateral view. F, frontal; Ip, interparietal; M, mental; N, nostril; Na, nasal; Nc, nasal cleft; O, ocular; P, parietal; Pf, prefrontal; Po, preocular; R, rostral; So, supraocular; 1-4, upper labials; I-V, lower labials.



## 6.—Observations on the Indo-pacific species of *Kraussia* Dana 1852 (Decapoda: Brachyura)

by R. Serene\*

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### Abstract

Ten Indo-pacific species of *Kraussia* are discussed and illustrated, and a key is provided for their identification. Five of the species are new, and described as *K. pelsartensis* and *K. roycei* from Western Australian waters, *K. bongensis* and *K. wilsoni* from the Sulu Sea area, and *K. marquesa* from the Marquesas Islands.

### Introduction

The present observations refer to the study of the collections of *Kraussia* of the Western Australian Museum, and the National Museum of Singapore. Five species, two from Australian waters, one from the Marquesas Islands and two from the Sulu Sea are new. With ten different species in hand an opportunity is provided to review the situation of the Indo-pacific species of *Kraussia* and to suggest a key for their identification. None of the type material of the previously-described species has been examined.

The genus *Kraussia*, with as type species *Kraussia rugulosa* (Krauss 1843), includes in the order of my key the following species: *rugulosa* (Krauss 1843), *quadriceps* Yokoya 1936, *wilsoni* nov. sp., *pelsartensis* nov. sp., *roycei* nov. sp., ?*nitida* Stimpson 1858, aff. *nitida*, *marquesa* nov. sp., *rastripes* Muller 1887, *integra* (De Haan 1835), *bongensis* nov. sp.

The species *porcellana* (White 1848) and *proporcellana* Ward 1936 are accepted as synonym of *rugulosa*. I am not sure of the position of *hendersoni* Rathbun 1902 as a valid species, considering the confused situation of *nitida*. The single non west Indo-pacific species of the genus is *K. americana* Garth 1939.

### Specific characters

(1) *Chelipeds*: The key of Balss (1922) mentions as species with reduced fingers only *integra*, and his key of 1938 mentions all species save *rugulosa*. The relative size of the two chelipeds one to another, and the relative size of the palm and the fingers in major and minor chelipeds must be distinguished. Three species, *rugulosa*, *quadriceps*, and *wilsoni* have the two chelipeds of nearly the same size with the palm and fingers somewhat elongate. Five species, *pelsartensis*, *roycei*, *nitida*, *integra*, and *bongensis* have one cheliped clearly larger than the other, the major cheliped having the palm higher and the fingers shorter than the minor. The other two species, *marquesa* and *rastripes*, have the two chelipeds of nearly the same size with high palm and short fingers similar. The shape and proportion of palm and dactylus could slightly vary within

one given species with the size of the specimen, but no sexual dimorphism seems to mark the chelipeds; those of females and males are identical on all species.

The extension on the palm of the black pigment of the fixed finger seems to be a specific character in some cases. On the superior border of the merus, a subdistal spine occurs some distance from the distal margin on nearly all the species; a second, smaller spine generally occurs on the distal margin.

(2) *Measurements*.—Rathbun (1902) gives a specific value to the fronto-orbital breadth in regard to the carapace breadth and the character is used in the key of Balss (1922). Balss (1935) thinks that the proportion of the two breadths can considerably vary on specimens of the same species, but he expresses his views only in regard to the definition of *hendersoni* Rathbun 1902 and with reference to few specimens examined, which in my opinion are perhaps not conspecific.

The breadth of the carapace is mentioned as specific characters in the key of Sakai (1939). Balss (1938) considers also that the proportion of the breadth to the length of the carapace (elongation of the carapace) has a questionable value as a specific character. I have only used this character to separate *roycei* from *pelsartensis*, because it is such a clearly diagnostic feature. However, the views of Balss deserve new consideration. In my key, the measurements are those of the specimens illustrated in the present paper and are in millimetres; the carapace breadth (cb) is the largest.

(3) *Anterior frontal margin*.—To have its full specific value the bilobate character of the frontal margin must be associated with the absence of preorbital teeth and the quadrilobate character to its presence. Among the species with bilobate front, *integra* presents on each lateral lobe a feeble concavity which could be interpreted as feebly quadrilobate when no comparative material is available. In the species with quadrilobate front, the outer lobe is generally a little more protuberant and broader than the inner.

In the present status of our knowledge, it would be unwise to give a specific value to the prominence of the frontal margin in regard to the inner, supra-orbital angle, and to the shape of the frontal lobes. Generally the species clearly differ from one another by those characters (depth and shape of median and submedian sinus, prominence and shape of the frontal lobes). Whether these characters show marked intraspecific variations is still uncertain. A significant example is illustrated by two specimens,

\* Singapore Museum, Singapore.

identified *marquesa*, in the present paper. Further observations could demonstrate that the frontal margin provides a means for specific differentiation.

(4) *Pre-orbital tooth*.—The pre-orbital tooth, which corresponds to a marked inner supra-orbital angle, is separated from the outer frontal margin by the sinus giving passage to the antennal flagellum. When the pre-orbital tooth exists, the antennal flagellum stands out of the orbit; when it does not exist, the flagellum stands in the orbit. Only the three species with bilobate fronts have no pre-orbital tooth. The term "pre-orbital tooth" is used with reference to the previous authors. It would be more appropriate to designate the character by indicating the presence or absence of the antennal sinus between the frontal margin and the inner supra orbital angle; in many cases the term "tooth" being really inadequate. The strong marking or, on the contrary, the disappearance in some cases of the sinus on the outer half of the supra orbital border, also serve for specific differentiation.

(5) *Carapace*.—The distinctly separate, long, acute, forwardly-directed 4 spines on the lateral margin of the carapace behind the extraorbital angle only exists on *rugulosa*. Nearly all the other species have one notch situated at some distance (approximately one-third of the total length of the lateral margin) behind the extra-orbital angle; sometimes this notch is marked posteriorly by a larger spinule of the lateral margin. On some species, *pelsartensis*, *marquesa* and *bongensis*, a second notch (like a small concavity) is situated immediately behind the extra-orbital angle. Other notches can mark the lateral borders, for example, *quadriceps* presents two other feebler notches situated posterior to that corresponding to the anterior third of the lateral border. Sakai (1939) mentions that on *nitida* "one or two shallow indentations occur behind" that of the anterior third. All these structures are more easily observed on the ventral side and probably have a specific value. Comments on their possible function are given at the end of the present paper.

In some species, the dorsal convexity of the carapace is comparatively stronger than in the other species. The ornamentation (granules, setae) of the carapace seem to be specific. However, the rugae on the dorsal surface of *rugulosa* clearly differ from those of other species. The smoothness of the dorsal surface of some species is conspicuous.

(6) *Third maxilliped*.—The ratio of the total length of the third maxilliped to its largest breadth (ischium) is on *rugulosa*: 3.14, *quadriceps*: 2.90, *marquesa*: 2.70, *integra*: 2.60, *rastripes*: 2.57. These discrepancies are not sufficient for specific differentiation but could assist to improve the grouping of the species; the case of the elongate third maxilliped of *rugulosa* is the most significant.

(7) *Pereopods 2-5*.—The upper (anterior) border of the dactyli of pereopods 2-5 on all species tend to be proximally flattened, the two (anterior and posterior) margins of the upper border forming a kind of distinct carinae. Such

a structure varies with the species on pereopods 2-4 and is always more developed on pereopod 5. Only on *rastripes* is it fully developed on pereopods 2-4 which, like pereopod 5, is sharply denticulate along the anterior and posterior margins of the upper border. On the other species, the flattening of the proximal part of dactylus is always (at least on pereopods 3-4) short and the main part of the upper (anterior) margin is like the edge of a blade, generally concave, sometimes sinuous, sometimes straight, sometimes with a row of small denticulations, sometimes smooth. These differences seem to have specific value. Comparison of the dactyli of pereopods 4 and 5 provide an accurate means to separate the species. The posterior margin of the dactyli is always like the edge of a blade and convex. The largest breadth of dactyli in relation to length could also sometimes give a specific discrepancy, but more observations are needed.

(8) *Male pleopod*.—Pleopod 2 is short. Pleopod 1 has been illustrated by Sakai (1934, fig 17a, b) for *integra* and *rugulosa*, Stephensen (1945, fig. 33) for *?nitida*, Barnard (1950, fig 36c) and Buitendijk (1960, fig 1b) for *rugulosa*, and Buitendijk (1960, fig 1a) for *integra*.

All the ten species have pleopod 1 with the same elongate and slim stem. However their clear differences from one another in regard to the distribution of subdistal spines and setae and the shape of the apex provide the most secure specific character. The illustrations of pleopod 1 given by previous authors are generally insufficient to allow positive identification.

Several of the specific characters given in the following key and in the illustrations could present intraspecific variations which in some cases are sufficient to mislead identification. More exhaustive observation, taking into consideration the size and sex of the specimens, would probably define other new and secure specific discrepancies. It also will improve the grouping of the species; already *rugulosa* clearly seems to belong to a group quite separate from the other species.

#### Note on the Illustrations

As in many other cases, lack of illustration is the main obstacle to identification of the species of *Kraussia* described and recorded previously. Special care has therefore been taken to illustrate the present material.

The photographs and drawings are made by the author with a Projectina. On the drawings under the largest magnification (x450 on the screen), the lines representing the outlines of each apex correspond to the projection of a selected contour, which varies with the position of the pleopod on the slide. The selection partly reflects the personal interpretation of the author for the shape of the apex; other observations could offer more accurate or different interpretations. The setae of the apex are generally on the ventral side (at least the largest), and their origins are sometimes indicated on the drawings by dotted lines. In any case, the size of the specimen must always be taken into consideration when comparing drawings of pleopod 1.



# Key for the Indo-pacific Species of Kraussia

- 1 Lateral border of carapace denticulate with 4 salient separate acute spines behind extraorbital angle. Dorsal surface of carapace with short transverse rugae. Front feebly prominent in regard to pre-orbital teeth which are salient and separated from frontal margin by a deep incision (antennal sinus). Both chelipeds similar subequal with outer surface ornamented with transverse rugae; fingers somewhat elongate (fixed finger a little longer than superior border of palm). Large gaping between fingers which at tip are deeply hollowed. Size: 16.5x19 .... *rugulosa* (Krauss 1843)  
Lateral border of carapace always more or less regularly denticulate without distinctly longer and more salient spines; generally 1 but sometimes 2-3 notches marked. Dorsal surface of carapace granular or nearly smooth; sometimes granules arranged in short ripple-like transverse rows but not forming clear transverse rugae. Fingers of both chelipeds without hollowed tip .... 2
- 2 (1) Pre-orbital tooth marked. Front quadrilobate .... 3  
Pre-orbital tooth absent. Front bilobate .... 8
- 3 (2) Fingers of cheliped not remarkably shortened. Both chelipeds nearly identically shaped, one being only a little larger than the other. Palm not or very little swollen with outer surface nearly smooth. Cutting edge of fixed finger of cheliped with an elongated subdistal tooth, which is less marked on minor cheliped. Carapace punctate with small granules arranged in feeble and short transverse ripples near frontal and antero-lateral borders .... 4  
One cheliped or both chelipeds with remarkably shortened fingers and palm swollen .... 5
- 4 (3) Both chelipeds with palm and fingers similarly elongate; major cheliped a little longer than minor cheliped, but with less high palm. Fixed finger approximately as long as height of palm on minor cheliped, much longer than height of palm on major cheliped. On cutting edge of fixed finger of minor cheliped a well marked elongated subdistal tooth; nearly absent on major cheliped. Black pigment of fixed finger not extending on palm of cheliped. Frontal lobes rounded, deeply separated and strongly prominent beyond preorbital teeth. Dactyli of pereopods 3-4 sickle shaped with anterior border concave. Male pleopod 1 with apex bent laterally and a subdistal bunch of long setae. Size: 17x19 .... *quadriceps* Yokoya 1936  
Both chelipeds of same length with palm clearly higher and fingers shorter than on *quadriceps*. One cheliped (major) with palm higher and finger shorter than the other (minor). Fixed finger shorter than length of upper border of palm on major cheliped, longer than upper border of palm on minor cheliped. Black pigment of fixed finger a little extending on palm. Frontal lobes not deeply separated and slightly prominent. Dactyli of pereopods 3-4 with anterior border straight. Male pleopod 1 with apex straight truncate without subdistal bunch of long setae. Size: 11x12 .... *wilsoni* nov. sp.
- 5 (3) Both chelipeds with palm nearly smooth; upper border of dactyli feebly carinate and granular on proximal part only .... 6  
Both chelipeds with palm ornamented distally with a transverse row of large granules and at least on its distal part smaller granular ripples. Upper border of dactyli strongly carinate and granular .... 7
- 6 (5) Carapace remarkably broad with front-orbital breadth subequal to half breadth of carapace. Frontal margin with widely open median sinus. Major cheliped with strongly swollen palm and short fingers; length of fixed finger much less than half height of palm. Minor cheliped with slim elongate fingers regularly tapering; fixed finger bent downwards with length nearly equal to height of palm. Dactyli of pereopods 2-5 with anterior border nearly straight, flattened and acutely granular at least on proximal half. Apex of male pleopod 1 straight, without subdistal bunch of long setae. Size: 14.6x18. .... *pelsartensis* nov. sp.  
Carapace moderately broad with fronto-orbital breadth clearly less than half breadth of carapace. Frontal margin with nearly closed median sinus. Major cheliped with palm feebly swollen and fingers moderately elongate; length of fixed finger clearly more than half height of palm. Minor cheliped as in *pelsartensis* but with fixed finger not bent downwards with strong subdistal tooth on cutting edge; dactylus broader and more canaliculate. Dactyli of pereopods 2-5 with anterior border sinuous without marked flattening and devoided of granules. Apex of male pleopod 1 as a short beak bent at 45° with a subdistal bunch of long setae. Size: 13.2x14 .... *roycei* nov. sp.
- 7 (5) Both chelipeds clearly unequal; palm of major cheliped higher than that of minor cheliped; dactyli of at least minor cheliped not remarkably recurved; fixed finger of major cheliped clearly shorter than half height of palm, of minor cheliped clearly longer than half height of palm. No indication of black colour extending on palm. Frontal margin with closed median sinus. A clear sinus on outer part of upper orbital border. Dactyli of pereopods 2-5 sickle shaped without granules on anterior border. Male pleopod with apex bent at 50° and ornamented with a pre-apical bunch of long setae. Size: 9.8x10.8 .... *aff. nitida* Stimpson 1858  
Both chelipeds subequal; dactyli similarly and remarkably recurved and strongly granular. Fixed finger in one cheliped shorter than in the other; its length approximately one-fourth of height of palm instead of one-third in the other. Black

colour of fixed finger extending on palm. Frontal margin with a V-shaped open median sinus. No trace of sinus on upper orbital border. Anterior border of dactyli of pereopods 2-5 feebly concave (nearly straight) with granules only on pereopod 5. Male pleopod with nearly straight apex and a few subdistal setae. Size: 12.7x14

*marquesa*  
nov. sp.

- 8 (2) Dactyli of pereopods 2-5 with upper (anterior) margin nearly straight, flattened with on each side a row of acute granules. Dorsal surface of carapace nearly smooth, strongly and regularly convex in the middle. Antero-lateral borders of carapace regularly convex, thickly armed with acute granules without indication of any notch. No indication of sinus on upper orbital border. Two chelipeds subequal with short fingers identically shaped. On both chelipeds length of fixed finger approximately one-fourth of height of palm. Male pleopod distally acuminate with a subdistal bunch of long setae. Size: 11.1x12.8

*rastripes*  
Muller 1886

Dactyli of pereopods 2-4 with anterior border concave, flattened and granular only on short proximal part; anterior border of pereopod 2 with a row of some acute granules, those of pereopods 3-4 without granules. Dorsal surface of carapace granular. Antero-lateral borders of carapace with a notch at some distance behind the orbit. Strongly marked sinus on upper orbital border. Two chelipeds slightly but clearly unequal

- 9 (8) Frontal margin feebly undulate; dorsal surface of carapace slightly flattened. Both chelipeds with palm and fingers differently shaped. Major cheliped with palm higher, dactylus more recurved, fixed finger shorter than

on minor cheliped. Length of fixed finger one-fourth of height of palm in major cheliped, one-third of height of palm in minor cheliped; black colour of fixed finger not extending on upper half of palm. Male pleopod with apex acuminate. Size: 16x19.5

*integra*  
De Haan 1833

Frontal margin straight; dorsal surface of carapace regularly convex. Both chelipeds with palm and fingers identically shaped; length of fixed finger one-fourth of height of palm; black colour of fixed finger extending on upper half of palm. Male pleopod with apex broadened as a round lobe. Size: 20x23

*bongensi*  
nov. sp.

## Kraussia rugulosa (Krauss 1843)

(Figs. 1, 2, 23A)

*Platyonichus rugulosa*, Krauss, 1843, p. 26, pl.1, fig. 5.

*Trichocera porcellana*, White, 1848, p. 59.

*Kraussia rugulosa*, Dana, 1852, p. 302, pl. 9, fig. 1.—De Man, 1887, p. 343, pl. 14, fig. 2.—Borradaile, 1903, p. 270.—Rathbun, 1906, p. 876 (no material).—Stebbing 1910, p. 310.—1918, p. 54.—Balss, 1922, p. 98.—1938, p. 27, fig. 10.—Urita, 1926, p. 11.—Edmondson, 1925, p. 36.—1946, p. 284, fig. 175.—Sakai, 1934, p. 305, text-figure. 76b.—1936, p. 139, text-fig. 65.—1939, p. 431, text-fig. 21.—Tweedie, 1947, p. 28.—1950, p. 108.—Barnard, 1950, p. 195, fig. 36A, B. C.—Buitendijk, 1960, p. 253, fig. 1b.

*Kraussia proporcillana*, Ward, 1935, p. 10, pl. 1, fig. 7.

Type locality: South Africa.

**Material.**—WAM.262-70, series of 6 specimens, largest male of cl:16.5, cb:19.0, Loc: Flying Fish Cove, Christmas Island, Coll: Mr. Powell, 23.6.1961, Det: *proporcillana*; NMS.1965.10.10.3 male, Loc: Cocos Keeling, Coll: Gibson Hill, 1941, Det: Tweedie, 1950, p. 108; NMS.1965.10.10.2, male of cl:10, cb:11.40, Loc: Christmas Island, Indian Ocean, Coll: Gibson Hill, 1940, Det: Tweedie, 1947, p. 281; NMS. 1965.10.10.1, Loc: Christmas Island, Coll: Ward, 1934, Paratype specimen of *K. proporcillana* Ward, 1934, Balss (1938, p. 28) corrected as *rugulosa*.

**Remarks:**—The two chelipeds differ slightly; one has its palm a little longer and higher with rugae of the outer surface more marked than the other. The male pleopod is like that illustrated by Barnard (1950) and has a distally broadened apex with a subdistal bunch of long setae; it also has some heavy short pre-apical spines which are not indicated on Barnard's figure. Laurie (1906), examining the type of *porcellana*, stated it to be identical with *rugulosa* as suggested by Dana (1852). Ward (1934) separated *proporcillana* from *rugulosa* and considers *porcellana* as a distinct species. The syntype of *proporcillana* deposited in the National Museum of Singapore does not present any discrepancy in regard to the present series and confirms the views of Balss on the identity of the two forms. However, the comparison of the Type specimen of *rugulosa* or a topotype from South Africa or material from Japan and Hawaii with the types of the species of *proporcillana* and *porcellana* (the two in the British Museum) could suggest that more than one species should be recognised.



Figure 1.—Male pleopods 1 and 2 of *K. rugulosa*, WAM 262-70 of cl:16.0, cb:16.5.



The recorded size of specimens are by De Man (1887) 17.5x20.75; Sakai (1939) a male of 17x20; Barnard (1950) one male of 13x15 and one female of 11x12; Ward (1934) three specimens of 8.5, 10, 12 as carapace width. The species is recorded from South Africa (Krauss, Stebbing, Barnard), Philippines (White), Hawaii (Dana, Rathbun, Edmondson), Mergui Archipelago (De Man), Minikoi, Laccadives (Borradaile), Gilbert Islands, Ellice Islands, Samoa Islands, Marshall Islands (Balss), Christmas Islands in Indian Ocean (Ward), Tweedie, Cocos Keeling Islands (Tweedie), Timor (Buitendijk), Japan, Formosa (Urita, Sakai).

***Kraussia quadriceps* Yokoya 1936**

(Figs. 3, 4, 23B)

*Kraussia quadriceps*, Yokoya, 1936, p. 143, fig. 9.—Sakai, 1939, p. 431.

Type locality: Japan.

**Material.**—WAM.266-70, male of cl:17, cb:19, Loc: North Steamboat Island, Dampier Archipelago, N.W.A., 14 faths Hon. drge, Coll: Royce on "Davena", Date coll: 27.5.1966; WAM.273-70, male of cl:10, cb:11.5, Loc: 20 miles N. of Delambre Is., Dampier Arch., N.W.A., Source: B. R. Wilson on "Davena", Date coll: 7/6/1960; NMS. 1970.1.3.1., female with cl:12.00, cb:13.00, carapace with only one cheliped and no other

pereopod, Loc: Colombo, Ceylon, R. Serene coll. 1966.

**Observations.**—*The present specimens have:* (1) the front salient with four lobes anteriorly rounded (the left is damaged on the illustrated specimen and deeply separated).—2) the two chelipeds similarly shaped, with the palm and fingers elongate and smooth, but slightly unequal; one cheliped is a little longer than the other with palm less high; the cutting edge of the fixed finger of shorter cheliped has an elongate subdistal tooth, which is very feeble on the other cheliped. Also, the cutting edge of dactylus of the shorter cheliped has a proximal low tooth which does not exist on the other cheliped.—3) a notch marking the posterior limit of the anterior third of lateral border and with a distinct tooth behind; a second notch situated more posteriorly is well marked.—4) the dactyli of pereopods 2-5 sickle shaped and elongate with concave anterior border.

Their identity with *quadriceps* appears valid. The low elongate tooth of the cutting edge of the fixed finger is not indicated on the description of Yokoya (1936), who only mentions: "thumb of chela normally well developed." The male pleopod 1 has its apex bent nearly at right angle to form a transverse beak and presents on one side a large bunch of very long setae. Examination of the type specimen for these

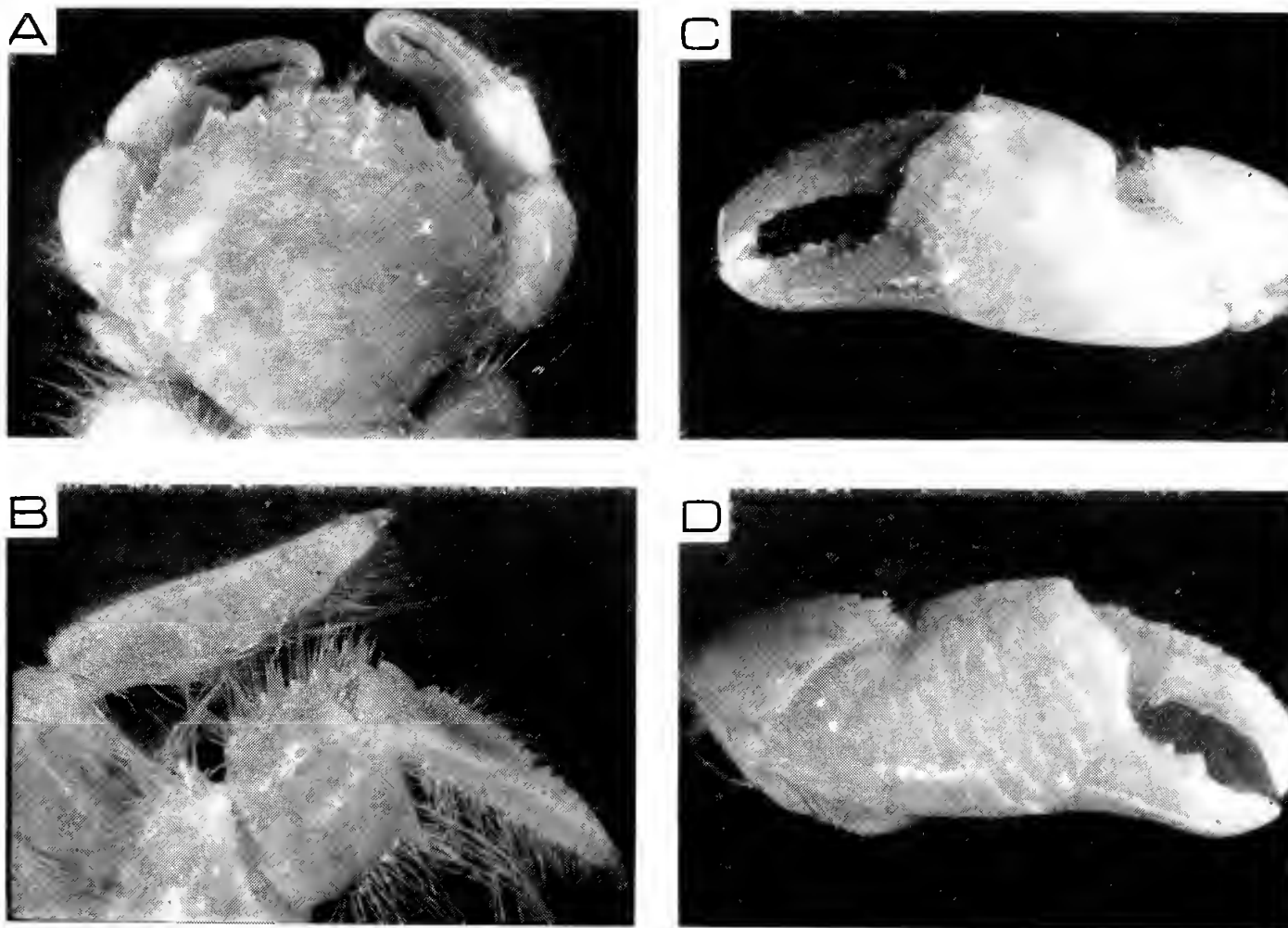


Figure 2.—*Kraussia rugulosa*, WAM 262-70, male of cl:16.5, cb:19.0. A, entire animal.—B, pereopods 4, 5 (ventral view).—C, right cheliped.—D, left cheliped.

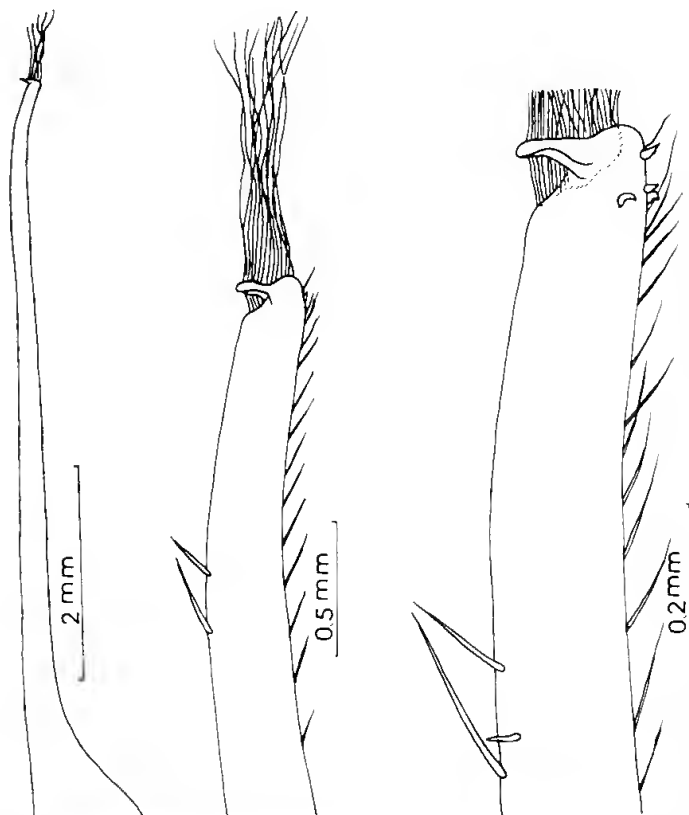


Figure 3.—Male pleopod 1 of *K. quadriceps*, WAM 266-70 of cl:15.3, cb:16.6.

characters of the male pleopod 1 and for the fixed finger would confirm or modify the present identification.

On the largest specimen the dactyli of the pereopod 5 are missing on the two sides. Those of the smaller specimens (273) are illustrated as indicated on the text of the plate. The fronto-orbital breadth of *quadriceps* is comparatively narrower than any other species of *Kraussia* and is clearly less than half of the largest breadth of the carapace. In all other species it is a little more than half. *K. quadriceps* was previously known by the single type specimen, a male of cl:10.7, cb:11.3, from Japan.

***Kraussia wilsoni* nov. sp.**

(Figs. 5, 6, 23C)

Type specimen: Western Australian Museum, Perth.

Type locality: off Siasi Island, Sulu Archipelago.

*Type material*.—Holotype, WAM.278-70, male of cl:11, cb:12; Paratype, WAM.143-71, female of cl:9, cb:10.5, Loc: North of Siasi Is., Sulu Arch., 20-22 faths., sponges, coral and sand, Coll: B. R. Wilson on "Pele", 17/2/1964; WAM.38-71, one female of cl:8, cb:9, Loc:  $\frac{1}{2}$  mile from Don Can Is., Laparan Group, Sulu Arch., 30 faths., sand and lithothamnion, Coll: B. R. Wilson on "Pele", 21/2/1964.

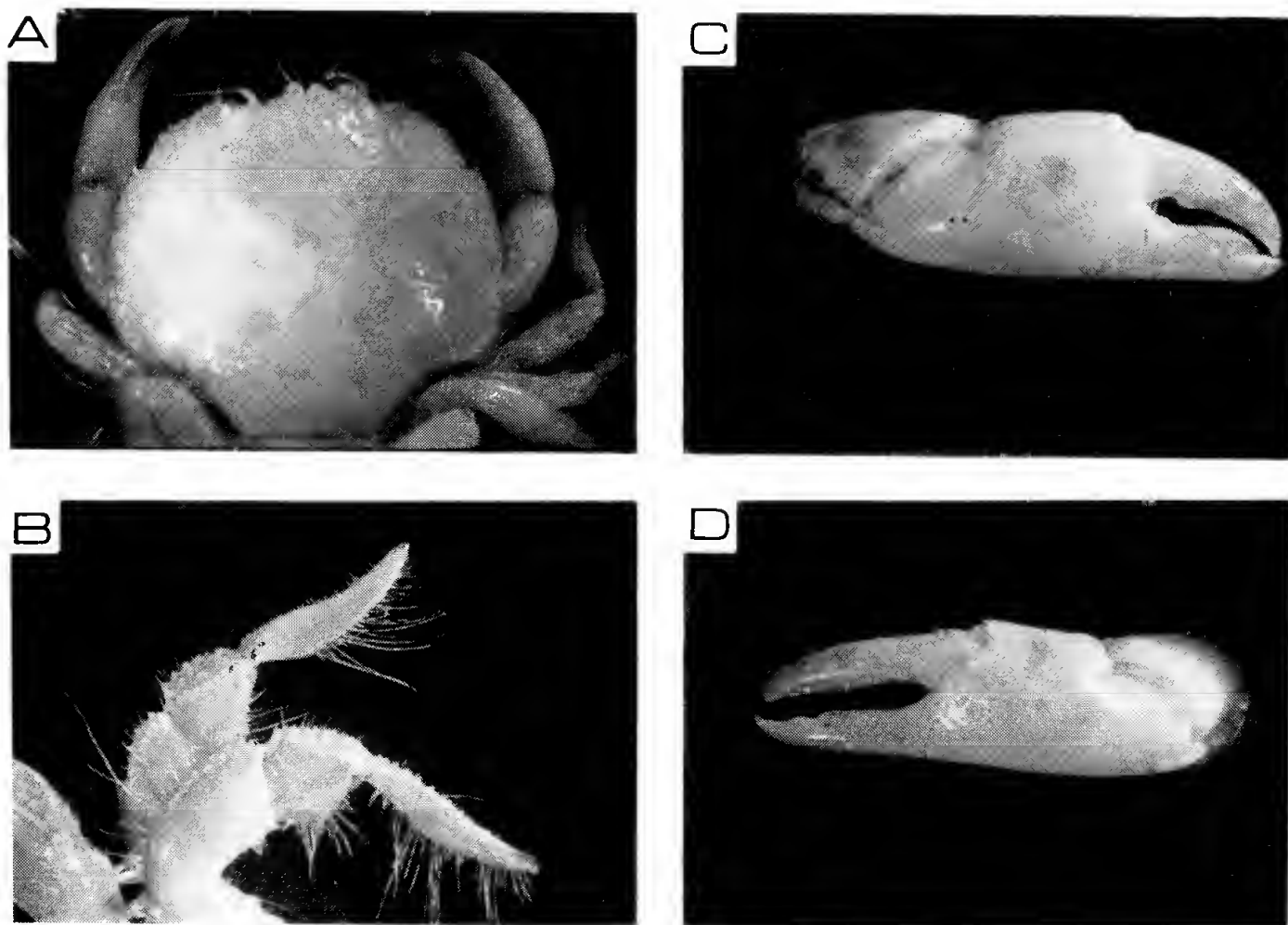


Figure 4.—*Kraussia quadriceps*, WAM 266-70, male of cl:17.0, cb:19.0. A, dorsal view.—B, pereopods 4, 5 (of WAM 273).—C, right cheliped.—D, left cheliped.

**Diagnosis.**—Carapace nearly smooth, punctuate with some granules on the area close to frontal and antero-lateral margins. Frontal margin consists of four round lobes, only a little salient beyond the inn r supra orbital angle which is blunt, like the extraorbital angle. Antero-lateral margin of carapace with a feeble notch. Both chelipeds smooth with same length but one with palm higher and finger a little shorter than on the other. Both fingers relatively strong, normally developed, longitudinally carinate, their length clearly less (0.63 on major cheliped, 0.78 on minor cheliped) than height of palm; cutting edge of fixed finger of major cheliped with a low elongate subdistal tooth; cutting edge of dactylus with a proximal large low tooth. No clear tooth on cutting edge of fingers of minor cheliped. On both chelipeds brown colour of fixed finger extends a little on palm. Anterior border of the pereopods 2-5 nearly straight with a longitudinal row of small granules. Granules a little acute and extend nearly all along on pereopod 2; feeble on pereopod 5 and limited to the proximal part on pereopods 3 and 4. Male pleopod devoid of any bunch of setae, with truncate apex, ornamented with subdistal acute spinules, larger and more numerous on outer side.

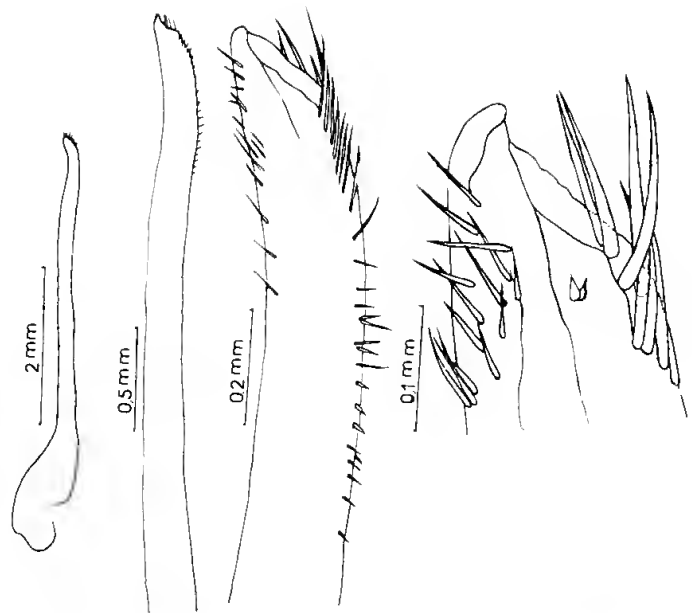


Figure 5.—Male pleopod 1 of *K. wilsoni*, WAM 278-70 of cl:10.0, cb:10.8

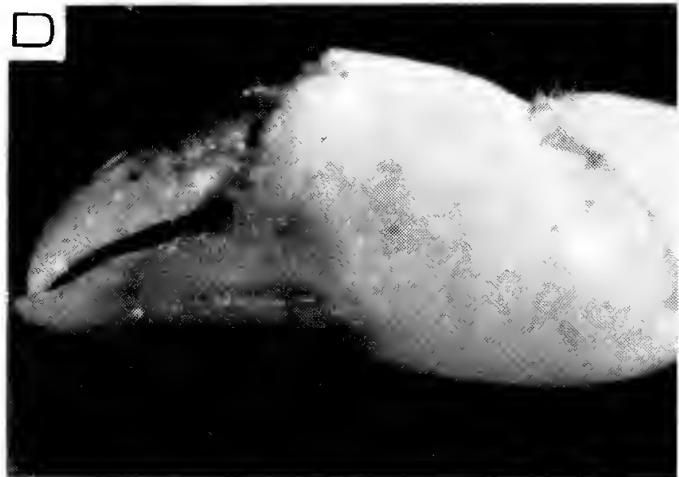
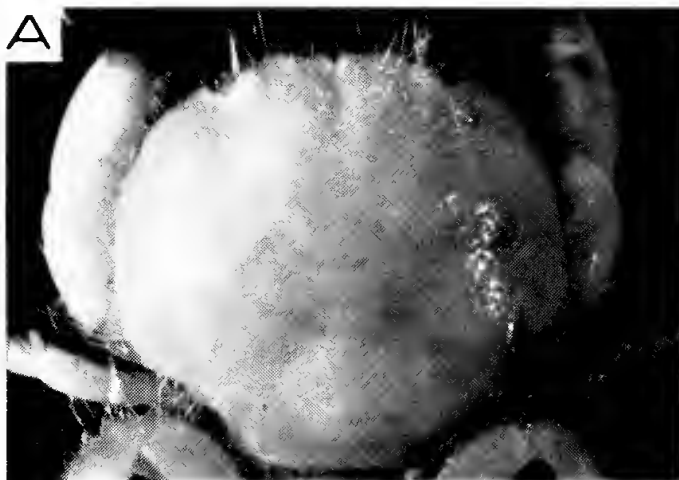


Figure 6.—*Kraussia wilsoni*, WAM 278-70, male of cl:11.0, cb:12.0. A, dorsal view.—B, pereopods 2, 3.—C, major cheliped.—D, minor cheliped.

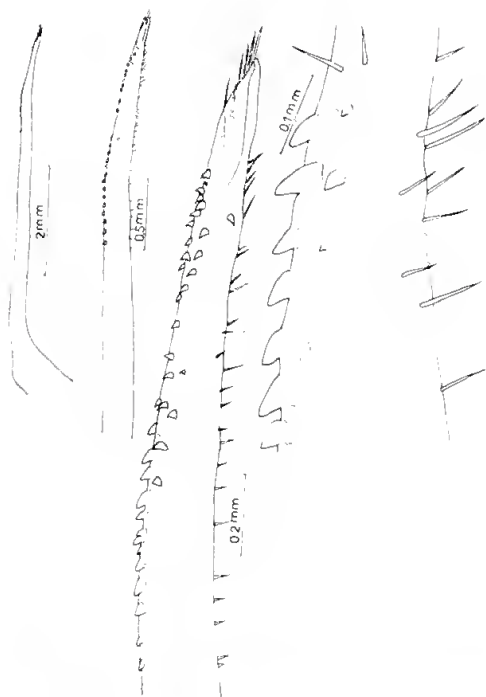


Figure 7.—Male pleopod 1 of *K. pelsartensis*, WAM 265-70 of cl:13.3, cb: 15.6.

**Observations.**—The paratype (smaller female) has the pre-distal tooth developed on the cutting edge of the fixed finger of the two chelipeds. Such a difference could be related to the different size as well as to the sex of the specimen. On the small female (WAM38-71) the discrepancies in regard to the holotype is more accentuated; the difference between the major and the minor chelipeds is stronger, the major having comparatively a palm higher and the fingers shorter; the tooth on the cutting edge of the fixed finger is particularly large. The minor cheliped is more elongate, with dactylus more deeply carinate and granular on superior border. The extension of the brown colour of the fixed finger on the palm is already marked.

By the shape of its carapace and chelipeds, *wilsoni* is closer to *quadriceps* than to any other species, but it clearly differs by several characters of the front, the chelipeds, the dactyli of the pereopods 2-5 and the male pleopod 1. The fronto-orbital breadth is clearly more than half the largest breadth of the carapace, instead of being clearly less on *quadriceps*.

The species is dedicated to Dr. B. R. Wilson from the Western Australian Museum, who collected the Type material, as well as an important part of the other material used for the present paper.

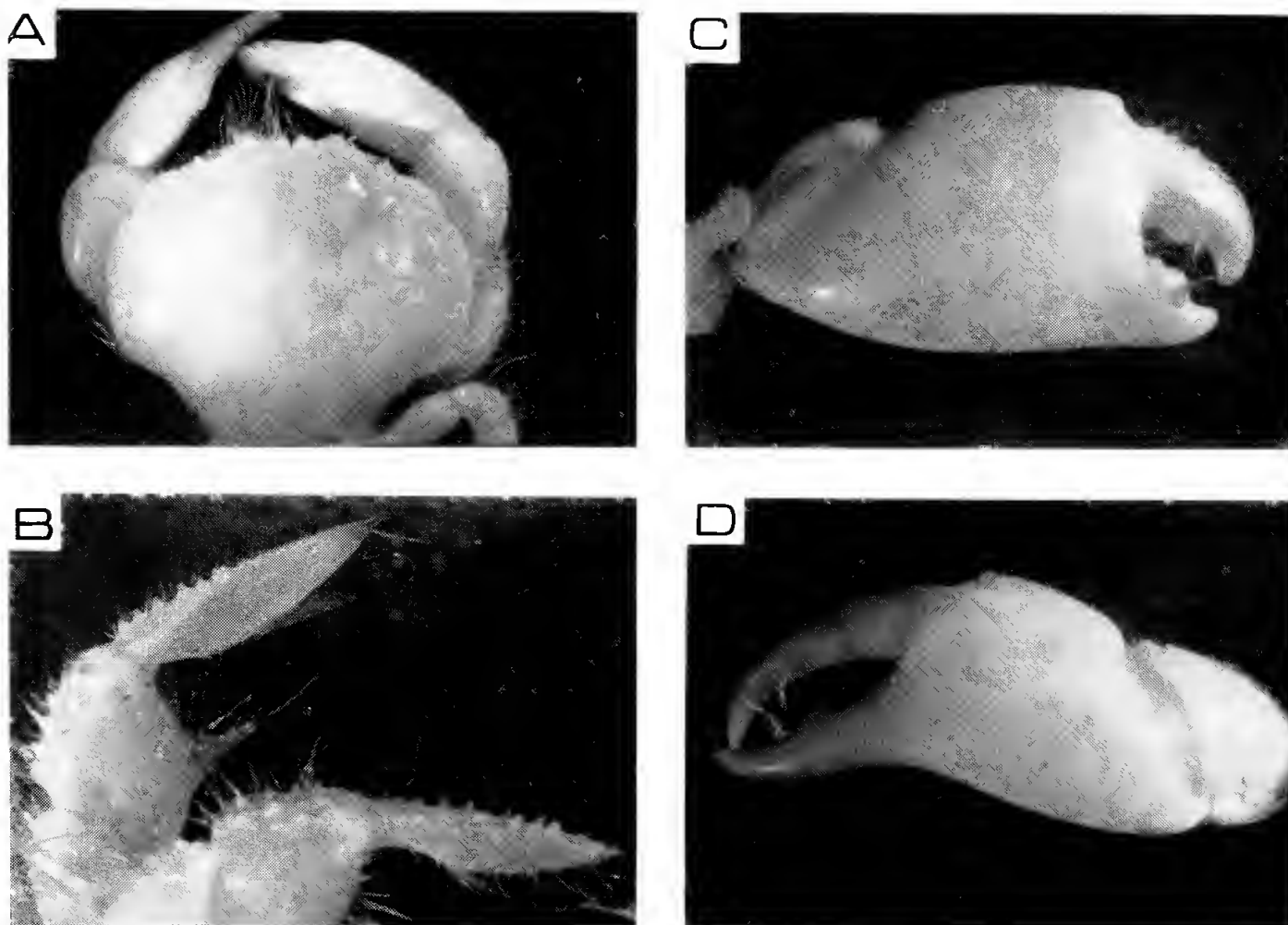


Figure 8.—*Kraussia pelsartensis*, WAM 265-70, male of cl:14.6, cb:18.0. A, dorsal view.—B, pereopods 4, 5 (of WAM 270).—C, major cheliped.—D, minor cheliped.



***Kraussia pelsartensis* nov. sp.**

(Figs. 7, 8, 23D)

Type specimen: Western Australian Museum, Perth.

Type locality: off Hummock Island, Pelsart group, Abrolhos.

**Material.**—Holotype, WAM.265-70, male of cl:14.6, cb:18, lacking pereopods 2-5 on left side, and pereopod 4 on right side, Loc: 3 miles, west Hummock Island, Pelsart Group, Abrolhos, 20 faths., Source: R. W. George on "Davena", 2.6.1960; Paratypes, WAM.268-70, 2 males, one of cl:14.5, cb:18, another of cl:12, cb:14.5, Loc: Cape Vlaming, Rottnest Island, Source: B. R. Wilson, Date coll: 1/3/1962; WAM.270-70, male of cl:13, cb:16, Loc. S.W. of Point Cloates, 113° 39' 30"E, 22° 43' 30"S, Source: Ningaloo Exped., 7/9/1968; WAM. 274-70, 2 males, the largest of cl:19.5, cb:11, Loc: N.W. Rat Island, Abrolhos Group, Honolulu Dredge, 25 faths., coralline bank, Source: R. W. George on "Davena", Date coll: 12/5/1960.

**Diagnosis.**—Holotype. Carapace nearly smooth with some small flattened granules on the area close to the front and lateral border. Front quadrilobate with a deep open medium incision, little salient beyond the orbits. Inner supra orbital angle (preorbital spine) marked and

well separated from the front by the antennal sulcus but not acute. A small concavity is present behind extraorbital angle on antero-lateral margin of carapace, followed posteriorly by a convexity and a notch. Both chelipeds smooth, differently shaped but with palm of same length. Major cheliped with a swollen palm, as high as half its total length; both fingers short;

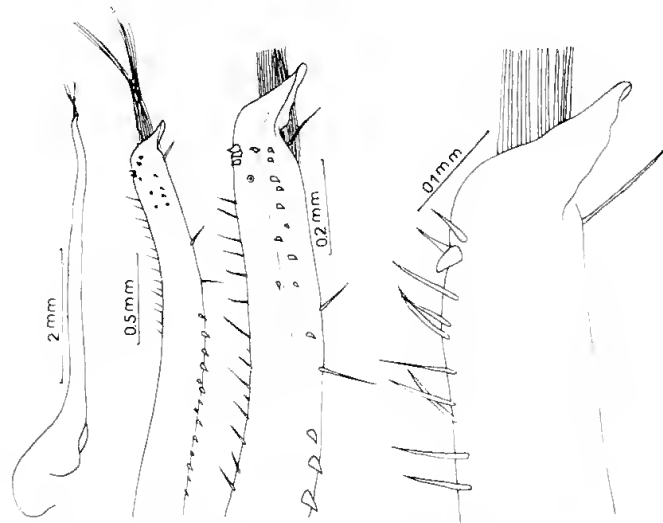


Figure 9.—Male pleopod of *K. roycei*, WAM 269-70 of cl:13.2, cb:14.

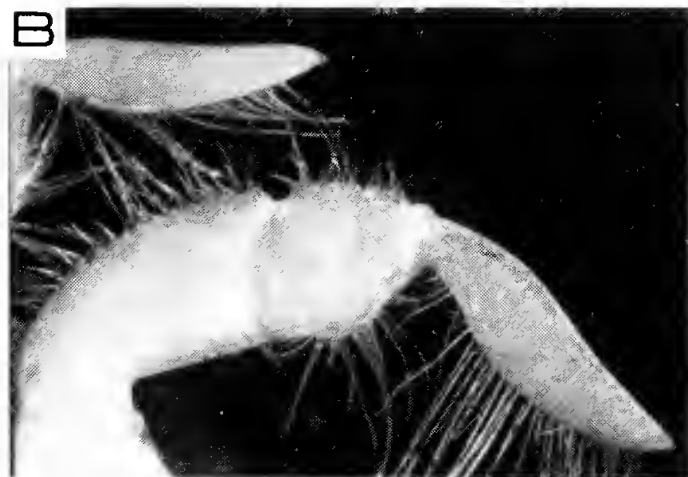
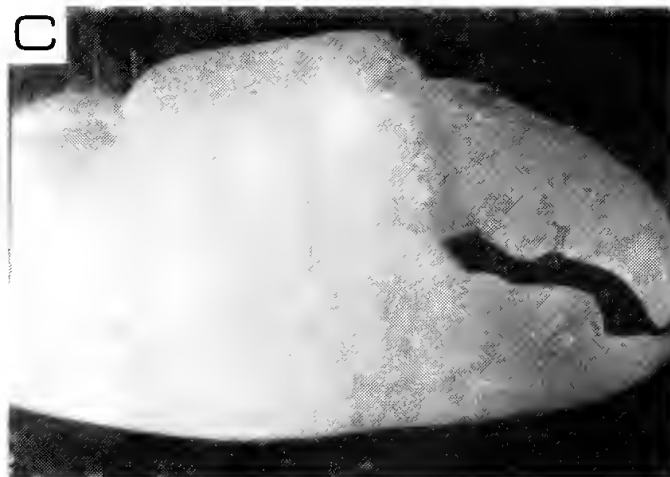
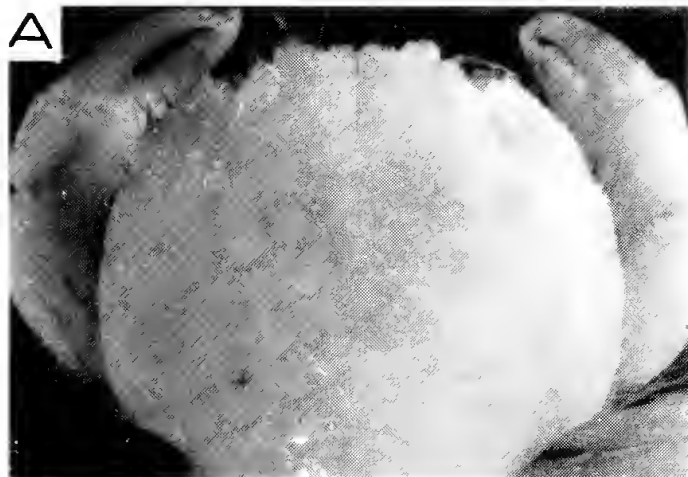


Figure 10.—*Kraussia roycei*, WAM 269-70, male of cl:13.2 cb:14. A, dorsal view.—B, pereopods 4, 5.—C, major cheliped.—D, minor cheliped.

fixed finger a little longer than one-third of height of palm. Dactylus with some granules on the proximal third of its superior border and one large rounded tooth on its cutting edge; fixed finger with two molariform teeth on its cutting edge, proximal tooth much smaller. Minor cheliped with palm somewhat elongate, clearly less high than half its length; both fingers, elongate, somewhat slim, tapering distally with tips crossing and a gap between them. Fixed finger nearly as long as height of palm; dactylus much longer; fixed finger bent downward, a concavity marking lower border of palm. Dactyli of pereopods 2-5 have anterior border nearly straight (feebly sinuous), posterior borders convex; all anterior border of pereopods 2 and 5 denticulate; only its proximal half denticulate on pereopod 3. Denticles stronger on pereopod 5; pereopods 4 missing on both sides of holotype. On paratype (WAM.270-70) anterior border of dactyli of pereopod 4 like on pereopod 3 of holotype but with denticle extending a little over its proximal half. Male pleopod with apex straight and ornamented on outer side by a subdistal row of 10 large but relatively short acicular setae; outer side of stem with a series of strong short spines on distal fifth part of its length, inner side only ornamented by some fine accicular spinules.

**Observations.**—On the largest male of the paratypes (WAM. 268-70), the two chelipeds are nearly similar with one another as size and shape; the two chelipeds have the palm and fingers elongate and are nearly like the minor cheliped of the holotype. The other paratype has only one cheliped which is like the minor cheliped of the holotype.

A somewhat smaller specimen (WAM.274-70) has the fingers of the major cheliped comparatively less shortened than on the holotype. The other specimen (WAM.274-70) is much smaller (probably juvenile) and has the two chelipeds clearly unequal and dissimilar, but the palm of the major cheliped is less swollen, the fingers are a little longer than in the holotype; the palm and fingers of the minor cheliped are a little shorter than in the holotype. The concavity behind the extraorbital angle is well marked. The dactyli of the pereopods 2-5 are identical with those of the paratype.

The conditions of the chelipeds of the largest paratype could mislead in the use of my key for its identification as *pelsartensis*. However, the species is well characterized by: (1) its broad carapace.—(2) the shape of the chelipeds.—(3) the small concavity behind the extraorbital border.—(4) the dactyli of the pereopods 2-5 with acute granules on anterior border more developed on the pereopods 2 and 5.—(5) the male pleopod. The name of the species refers to the Pelsart Group of the Abrolhos Islands, where the type material was collected.

***Kraussia roycei* nov. sp.**

(Figs. 9, 10, 23E)

Type specimen: Western Australian Museum.

Type locality: Dampier Archipelago, Australia.

**Material.**—Holotype, WAM.269-70, male of cl:13.2, cb:14, Loc: Flying from Passage,

Dampier Arch., Source: R.D. Royce on "Davena", Date coll: 30/5/1960.

**Diagnosis.**—Carapace with finely granular ripples all over. Front quadrilobate salient beyond the orbits and with nearly closed median incision. Inner supra orbital angle (pre-orbital spine) marked and antennal sulcus deep. Sinus on outer part of upper orbital border strongly marked and continued on carapace by a clear groove. Antero-lateral margin of carapace with only a feeble notch. Both chelipeds smooth with a palm of same height and same length but differently shaped; major cheliped with upper border of palm longer and two fingers shorter than on minor cheliped. Two fingers a little shorter than height of palm on major cheliped, much longer than height of palm on minor cheliped. Cutting edge of fixed finger of major cheliped with two low molariform teeth, the proximal feeble; that of minor cheliped with a strong subdistal tooth. Dactyli of pereopods 3,4,5 with anterior border slightly concave without denticle; that of pereopod 2 more straight with 2-3 small denticles on proximal half. Male pleopod with apex like a short beak bent at 45°, a subdistal bunch of long setae on ventral side, a pre-apical series of acute short thick spines on dorsal side and some similar spines at some distance on outer side of the stem.

**Observations.**—The species is close to *pelsartensis* and on first examination was considered only as a variety. The discrepancies of the male pleopod in particular supported the view of separate species. The holotype of *roycei* was compared with all the available material of *pelsartensis*, but particularly with the male of 13x16 (WAM.270-70) which has a carapace length nearly equal to that of *roycei*.

*K. roycei* differs from *pelsartensis* by the following characters: (1) The breadth of the carapace is 1.07 times its length, instead of being 1.22; the fronto orbital breadth is 1.86 instead of being 2.06 in *pelsartensis*.—(2) the front is comparatively more salient beyond the inner supra-orbital angle; the sinus of the upper orbital border more marked; the postfrontal region is more densely covered with long hairs than on *pelsartensis*, in which the hairs are limited around the frontal margin.—(3) There is no trace of the feeble but always clear concavity which marks the antero-lateral border of the carapace immediately behind the extraorbital border on *pelsartensis*.—(4) The carapace is more granular, the granules being arranged in fine transverse ripples.—(5) The merus of the cheliped does not have on the distal margin of the upper border, the distal spinule which exists on *pelsartensis*. The major cheliped differs less from the minor cheliped than on *pelsartensis*. The fingers of the major cheliped are longer and those of the minor shorter than on *pelsartensis*.—(6) The dactyli of pereopods 3-5 have the anterior border slightly concave without denticles instead of nearly straight with denticles on *pelsartensis*.—(7) the male pleopod with the apex like a short beak bent at 45° instead of straight on *pelsartensis*.

To support the discrepancy of the breadth of the carapace, the measurements of the specimens of *pelsartensis* (indicated by their regis-



tered number) in regard to those of *roycei* are given in the table below:

The species is dedicated to its collector, Mr. R. D. Royce.

### Kraussia nitida Stimpson 1858

*Kraussia nitida*, Stimpson, 1858, p. 40.—1907, p. 87, pl. 10 fig. 4.—Miers, 1884, p. 235.—Henderson, 1893, p. 379, pl. 37, fig. 9.—Alcock, 1899, p. 98.—Calman, 1900, p. 24.—Rathbun, 1902, p. 132, fig. 13.—1910, p. 366.—1911, p. 211.—Laurie, 1906, p. 421.—Balss, 1922, p. 98.—1935, p. 131.—1938, p. 271, fig. 11, 12.—Urita, 1926, p. 11.—Sakai, 1934, p. 305.—1935, p. 138, pl. 41, fig. 2.—1939, p. 430, pl. 52, fig. 2, text-fig. 20.—1965, p. 107, pl. 49, fig. 2.

*Kraussia integra*, Borradaile, 1902, p. 270 not *integra* De Haan fide Rathbun 1902.

?*Kraussia hendersoni* (under *nitida* pars), Rathbun, 1902, p. 132.

?*Kraussia hendersoni*, Rathbun, 1906, p. 875, pl. 14, fig. 2.—Balss, 1922, p. 98.—Montgomery, 1931, p. 433.

Type locality: Kagosima, Japan.

**Preliminary remarks.**—The descriptions and illustrations of *nitida* in the literature are ambiguous. In the absence of the type specimen which is lost like the main part of Stimpson's material, no better reference exists. The selection of a topotype specimen from Kagosima (or at least Japan), its designation as neotype and a redescription of the species seems to be necessary. Sakai (1934) records one made from Kagosima. Provisionally the descriptions and illustrations of *nitida* by Stimpson (1858, 1910) and Sakai (1939, 1965) for Japanese specimens must be considered as the most accurate. By their shorter and thicker chelipeds, the specimens from the Maldives illustrated by Rathbun (1902) and from Australia illustrated by Balss (1938) seem to belong to a different species. The specimen of Sakai is a little larger (9x9.5) than that of Rathbun (7.7x8.4) and a little smaller than that of Balss (10.5x13).

A specimen from the Irian Gulf is identified with reserve (*nitida* Stimpson?) by Stephensen (1945) and as such the illustration of its male pleopod cannot be used as reference for *nitida*. Only a re-examination of the type specimen of *hendersoni* (in the USNM) will allow one to confirm or deny the validity of the species contested by Balss (1935) but not by Sakai (1965).

The species *nitida* s.l., as it is understood by Balss (1938) for example, seems to correspond to a composite taxon including two or three different species, and it must be considered that no accurate definition of *nitida* exists.

### *Kraussia ?nitida* Stimpson 1858

(Fig. 11)

**Material.**—WAM.260-70, one female of cl:7, cb:7.5, Loc: West Approaches to Mermaid Str., Dampier Archipelago, W.A. Coll: R. D. Royce on

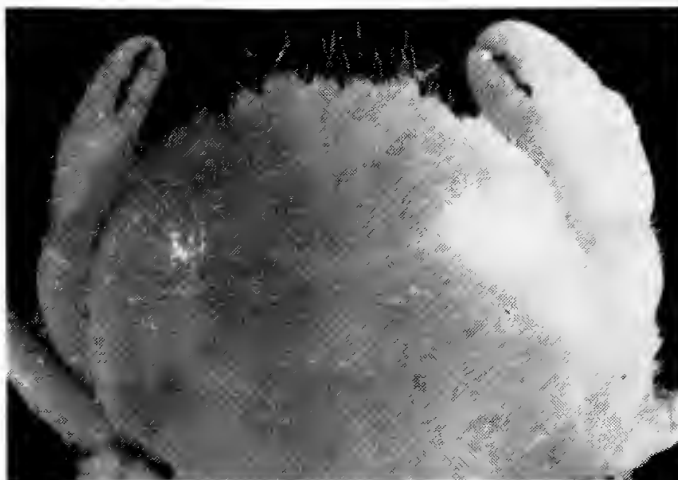


Figure 11.—*Kraussia nitida?*, WAM 261-70, female of cl:7, cb:7.5.

"Davena", 27.4.1960, Det: M. E. Clarke as *nitida*; WAM. 261-70, female of cl:12.2, cb:13, Loc: off Cape Cleveland Qsld., dredged 16 faths., Coll: W. Goode on "Dorothea", 24.11.1962, Det: M. E. Clarke as *K. nitida*.

**Observations.**—The two specimens have the lobes of the frontal border rounded. The chelipeds of the largest specimen (WAM 261-70) perfectly agree with the figures of *nitida* by Balss (1938) which illustrates a female of the same size. Even the fixed finger of the major cheliped has the two teeth on the cutting edge as illustrated by Balss (1938) the distal being comparatively much larger. On the minor cheliped, the fingers are a little larger and an elongate subdistal tooth is well developed on the cutting edge of the fixed finger. A re-examination of Balss's material or other new material from Australia and its comparison with Japanese material could demonstrate that these specimens belong to a species distinct from *nitida*. The specimens, being females, cannot provide information on the pleopod, and the use of the present material as type for a new species will be unwise. On the smaller specimen the palm and fingers, mainly of the minor cheliped, are much more elongate. Such material emphasizes the uncertain situation of *nitida* as understood by Balss (1938).

### *Kraussia* aff. *nitida*

(Figs. 12, 13, 23F)

*Kraussia (nitida* Stimpson?), Stephensen, 1945, p. 138, fig. 33.

**Material.**—NMS.1965.10.10.6, male of cl:10.5, cb:12, Loc: Pulau Paway, off Singapore, Coll: Tweedie 1934, Det: as *nitida* by Balss 1938, (handwritten label), not recorded in literature.

	(265)	(268A)	(268B)	(270)	(274)	<i>roycei</i>
carapace length .....	14.6	14.5	12	13	9	13.2
carapace breadth .....	18	17.8	14.5	16	11	14
ratio cb : cl .....	1.23	1.22	1.20	1.22	1.22	1.07

**Diagnosis.**—Frontal border feebly quadrilobate, median incision shallow, rounded lateral lobes little prominent and separated by a feeble concavity. Inner supra orbital angle little prominent and antennal sulcus shallow.



Figure 12.—Male pleopod 1 of *K. aff. nitida*, NMS. 1965.10.10.6 of cl:9.8, cb:10.8.

Two chelipeds with palm of same length; major cheliped with palm higher, upper border of palm longer and two fingers shorter than on minor cheliped. Fixed finger of major cheliped clearly shorter than half height of palm, of minor cheliped clearly longer than half height of palm. Outer surface of palm ornamented with a distal vertical row of large granules, and some other smaller granules distributed on distal half. Both chelipeds with superior border of dactyli canaliculated and granular on proximal half. Dactyli of pereopods 2-4 sickle-shaped and relatively elongate. Male pleopod 1 with apex bent nearly at right angle and a subdistal bunch of long setae; inner side of pre-apical region ornamented with a row of 13-14 acicular spines.

**Observations.**—The frontal margin with round lobes differs strongly from that of *nitida* illustrated by Sakai (1939) for a specimen of nearly the same size, as well as from the illustrations of any other authors. The chelipeds are nearly similar to those illustrated by Balss (1938, fig. 11, 12); the palm of the major cheliped is higher on Balss's figure than on the present specimen. On the figure of Balss (1938, fig. 11) the height of the palm is 0.62 its total length (fixed finger included) and 2.7 the length of the

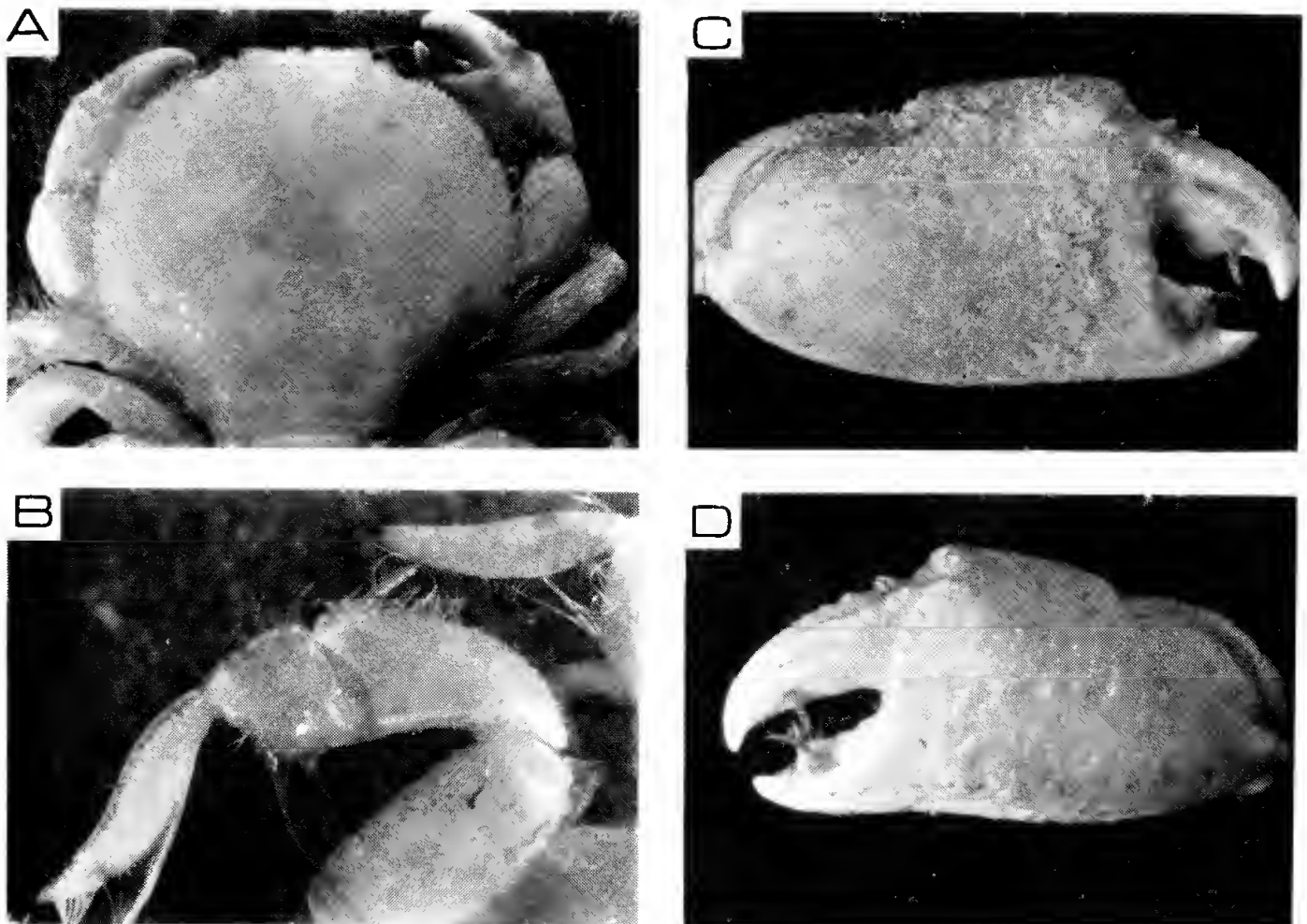


Figure 13.—*Kraussia aff. nitida*, NMS.1965.10.10.6, male of cl:9.8, cb:10.8. A, dorsal view.—B, pereopods 4, 5.—C, major cheliped.—D, minor cheliped.



fixed finger; on the present specimen it is respectively 0.56 and 2.5. The specimen of Balss (1938) was a female from Shark Bay, probably of breadth of carapace 14 supposing that he had illustrated his larger specimen; Balss records for 3 females from Shark Bay carapace breadths of 14, 11, 13.

Stephensen (1945) mentions that his specimen has the hands more slender than on the figures of Balss (1938) and also that "the fixed finger in right chela has but one tooth (besides the apical tooth) and the movable fingers of the hands are on the convex side smooth, not denticulate." The present specimen seems to agree with the first two characters given by Stephensen, but it has the dactyli clearly denticulate. The male pleopod of the present specimen is identical with that illustrated by Stephensen (1945, fig. 33) and suggests that the two specimens belong to the same species. The material of Balss (1938) or a part of it could also belong to the present form, of which the identity with *nitida* Stimpson has still to be demonstrated.

***Kraussia marquesa* nov. sp.**

(Figs. 14, 15, 23G and H)

Type specimen: Western Australian Museum.

Type locality: Anaa Atoll, Marquesas Island.

**Material.**—Holotype (WAM.264-70), male of cl.12.7 x cb:14; pereopods 2-5 left side missing, pereopod 2 right side separated but present, Loc: Anaa Atoll, Sta An IV +V, depth 30-60 feet, Coll: Marquesas Exped. 1967, Date: 29.10.1967; ? NMS.1969.11.20.5, male of cl:15.33, cb:18.66, Loc: Puerto Galera, Mindoro, Philippines, Coll: Univ. Philippines. One cheliped missing, only two ambulatory legs present. Dry specimen now re-generated and maintained in alcohol.

**Diagnosis.**—(Holotype). Carapace strongly granular all over; the margin of carapace with strong and acute granules. Front quadrilobate, salient beyond orbit and with an open deep median incision. Antennal notch well marked; no trace of sinus on upper orbital border. Lateral margin of carapace with feeble but clearly indicated lateral notch. Two chelipeds similar with high palm and short fingers. Fixed finger of right cheliped approximately one-third of height of palm, of the left cheliped one-fourth of the height of palm. Outer surface of the palm strongly granular with black pigment of fixed finger extending on palm.

Dactyli of pereopods 2 and 5 with strong acute granules on anterior border; one row of granules on that of pereopod 2 and two rows on that of pereopod 5; the dactyli of pereopods 3 and 4 sickle-shaped, and without granules on anterior border. Male pleopod 1 with apex nearly straight (a little bent) with a few subdistal long acicular setae and some strong short pre-apical spines.

**Observations.**—By its chelipeds with very high palm and short fingers, *marquesa* differs from *nitida* as illustrated by Stimpson (1907) and

Sakai (1939, 1965) as well as from *nitida* illustrated by Balss (1938). The two chelipeds with high palm and short fingers, the black pigment of the fixed finger extended on the palm as well as the strong granulation of the carapace of *marquesa* are characters close to those of *integra* and *bongensis* as described and illustrated in the present paper. *K. marquesa* differs from the two by the antennal sinus separating the front from the inner supra orbital angle, and the absence of sinus on the supra orbital border. That sinus is on those species always well marked and continued on the dorsal surface of the carapace by a longitudinal depression, distinctly indicated on the figure of Sakai (1939, 1965) and very clear on the specimens of the present collection.

The extension of the black pigment on the palm has, in my opinion, specific value as a character and must lead to a comparison of *marquesa* with *hendersoni*, a species separated from *nitida* by Rathbun (1902) mainly on the basis of the black pigment of the palm and the different shape of the front.

The specimen from Puerto Galera is identified with reserve as *marquesa*. It strongly differs from the holotype by its frontal border with median incision deeper and lateral lobes triangular and deeply excavated, inner supra-orbital

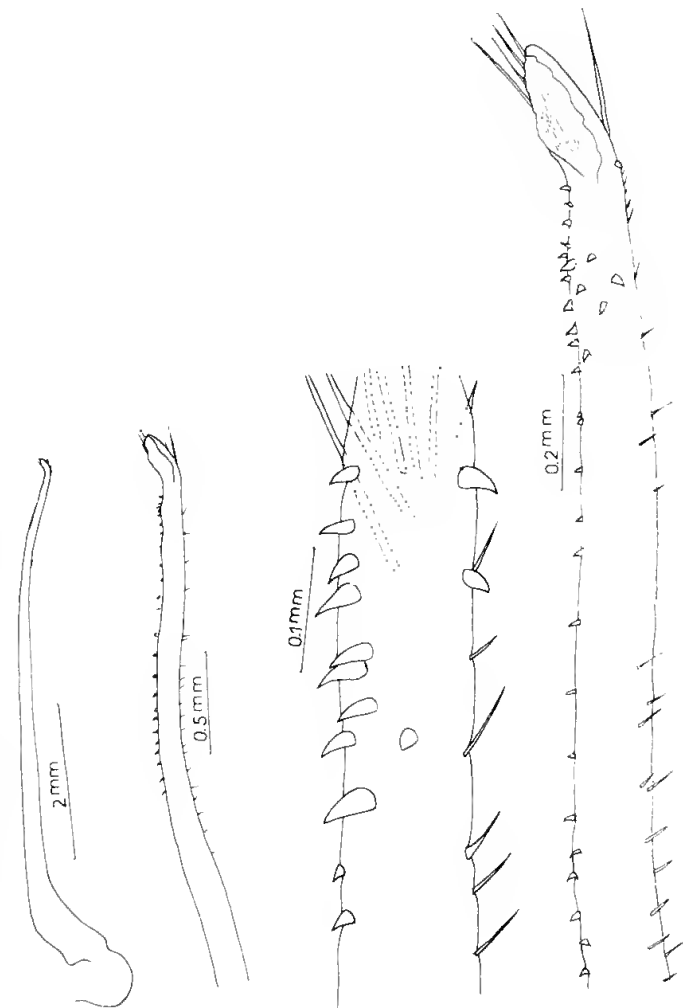


Figure 14.—Male pleopod 1 of *K. marquesa*, WAM 264-70 of cl:12.2, cb:14.

angle more acute, antennal notch deeper. (On the specimen the right inner supra-orbital lobe is broken). These characters agree with those described by Stimpson (1848, 1907), mentioned by Miers (1884), Henderson (1893), Alcock (1899), and illustrated by Henderson (1893, pl. 39, fig. 9), Stimpson (1907, pl. 10, fig. 4) and Sakai (1939, text-fig. 20, pl. 52, fig. 2 and 1965, pl. 49, fig. 2) for *nitida*.

Also its carapace is broader and front narrower than on the holotype. Measurements of the carapace of the holotype (1), the Puerto Galera's specimen (2) and the specimen identified *aff. nitida* (3) give the following ratios:

	(1)	(2)	(3)
carapace breadth/carapace length	1.14	1.19	1.10
frontal breadth/carapace length	0.40	0.38	0.40
frontal breadth/carapace breadth	0.35	0.32	0.37
fronto-orbital breadth/carapace breadth	0.55	0.53	0.55

The specimen of Puerto Galera has a carapace broader, and a front narrower, than the holotype of *marquesa* and the specimen of *aff. nitida*, which has the same frontal breadth as *marquesa* but a narrower carapace.

Rathbun (1902) indicates that on *nitida* "the fronto-orbital width is nearly two-thirds the full width of carapace" and on *hendersoni* "only half as great as that of carapace". By its narrower front as well as by the shape of its frontal margin the specimen of Puerto Galera is close to *hendersoni*. The chelipeds of *hendersoni* are slightly but clearly unequal on the photograph published by Rathbun (1906, pl. 14, fig. 2) and unfortunately the present specimen has only one cheliped. Besides, its male pleopod is so close to that of *marquesa* that at least provisionally it is considered as belonging to the same species. The name is a Spanish noble rank and recalls the area of the type material: Marquesas Island.

### *Kraussia integra* (De Haan 1835)

(Figs. 16, 17, 18, 23 I)

*Cancer (Xantho) integer*, De Haan, 1835, p. 63, pl. 13, fig. 6.

*Actumnus integra*, Richters, 1880, pl. 16, fig. 17, 18.

*Kraussia integra*, Rathbun, 1906, p. 875, pl. 14, fig. 3.—1911, p. 211.—Balss, 1922, p. 97 (no material).—1933, p. 29.—Gordon, 1931, p. 527 (in a list).—Sakai, 1934, p. 304, text-fig. 17a.—1936, p. 137, pl. 14, fig. 1, text-fig. 64.—1939, p. 429, pl. 52, fig. 1.—1963, p. 107, pl. 49, fig. 1.—Buitendijk, 1963, p. 233, fig. 1a.

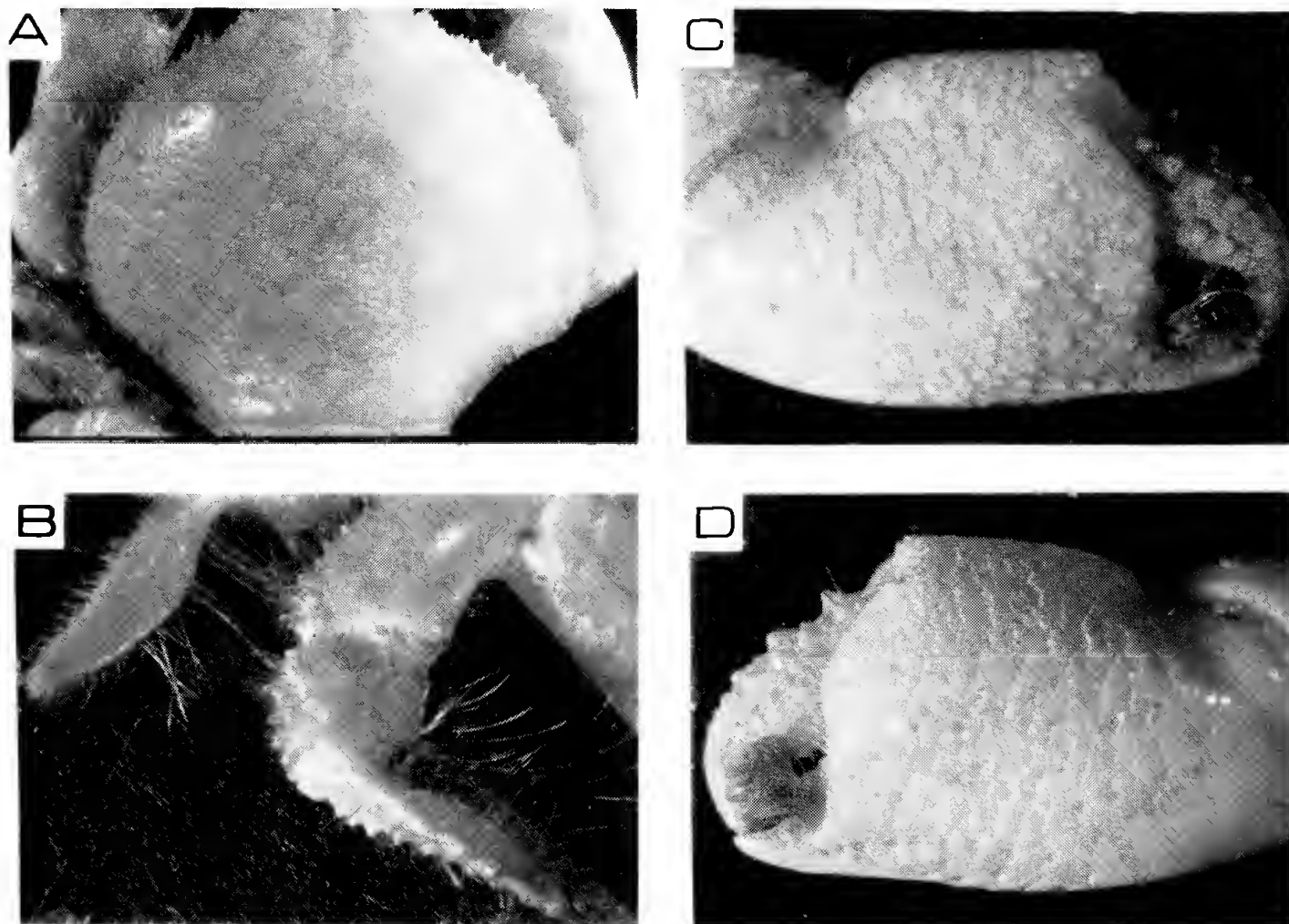


Figure 15.—*Kraussia marquesa*, WAM 264-70, male of cl:12.7, cb:14. A, dorsal view.—B, pereopods 4, 5.—C, right cheliped.—D, left cheliped.

Not *Kraussia integra*, Borradaile, 1902, p. 270 =  
*nitida* ãde Rathbun 1902.

Not *Kraussia integra*, Alcock, 1899, p. 97 = *rastripes*.

Not *Kraussia integra*, Tweedie, 1950, p. 108 = *ras-*  
*tripes*.

Type locality: Japan.

**Material.**—WAM.134-70, male of cl:15.33, cb:17.33, another much smaller specimen, Loc: 7 miles 260° from Zal Island Pearl Bank, Sulu Arch., Col: B. R. Wilson on Pele Exped. 21/2/1964, 10 fathoms, lithothamnion and sand; WAM.271-70, female of cl:12, cb:13, with only one cheliped, Loc: Stn. 2 E. of Cape Poivre, 20° 53'S, 115° 20'E, Date col: 24/8/1966, Hab: sand flats with rocks and sponges under stones, inter-tidal; WAM. 275-70, male of cl:10, cb:11 and one female of cl:13, cb:14, Loc:  $\frac{1}{2}$  mile S.W. of Don Can Is., Laparan Group, Sulu Arch., Source: B. R. Wilson on "Pele", Date coll: 21/2/1964, 30 faths., sand and lithothamnion; WAM. 276-70, damaged male of cl:9, cb:10.5, Loc: Sulu Archipelago, Source: B. R. Wilson on "Pele", Date coll: 2/3/1964; WAM. 277-70, male of cl:16, cb:19.5, Loc: 6-7 miles of Pearl Bank, Sulu Arch., 9-12 faths., coarse sand, Source: B. R. Wilson on "Pele", Date coll: 21/2/1964.

—Mariel King Memorial Expedition 1970: KR VI, north of Du Rowa Is., N. of Nuhu Rowa, Kai Islands, 5° 32'S, 132° 41'E; H3-10, 20 faths.,



Figure 16.—Male pleopod 1 of *K. integra* WAM 277-70 of cl:17, cb:19.5.

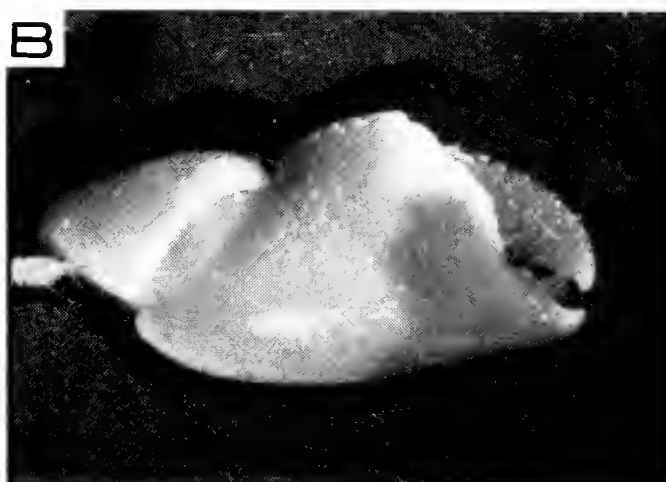
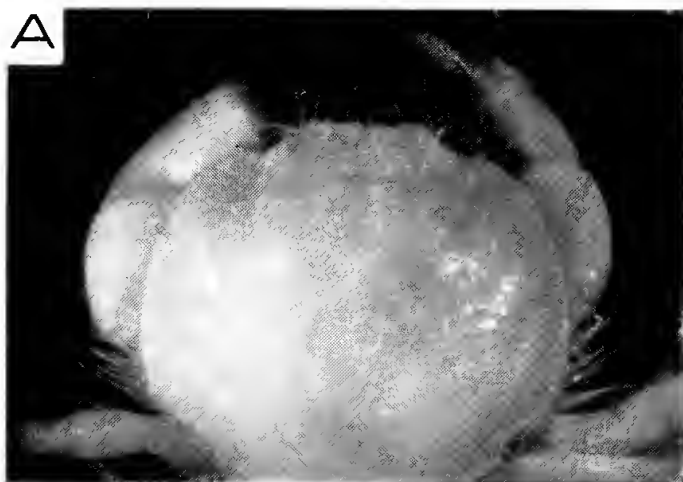


Figure 17.—*Kraussia integra*, WAM 277-70, male of cl:16, cb:19.5, A, dorsal view.—B, pereopods 4, 5.—C, right cheliped.—D, left cheliped.





Figure 13.—*Kraussia integra*, KR VI/H3-10, male of cl:9, cb:10, cheliped of juvenile.

sand and rubble, Date coll: 10/6/1970; KN II, off Elat Bay, west coast Nuhu Tjut, Kai, 5° 40'S, 139° 59'E; H3-4, 27-35 fms., rubble, fan coral, some sand and green algae, Date coll: 13/6/1970; CP II, off Tg. Tutuhuhur, Piru Bay, Ceram, 128° 8'E, 3° 15'S; H8-9, 20-26 fms., coarse sand, lithothamnion sand rubble, Date coll: 1/6/1970. The largest specimen (KR VI/H3-10) one male of cl:9, cb:10.

**Preliminary remarks.**—Apart from the original of De Haan (1835, not seen) the single accurate description of *integra* is that of Sakai (1939). It could be considered that no accurate illustration of the species exists in the literature at least in regard to the chelipeds, the best being those of Sakai (1939, 1965). A re-examination of the Type specimen or material from Japan would be essential to evaluate the present observations. The only reference in the literature to the size of the species is a male of 18x22.5 given by Sakai (1939), who recorded a total of 16 specimens.

Alcock (1899) quotes: "*K. rastripes* Muller" as a synonym of *integra* and Balss (1922) kept the same standpoint. In fact, the description of Alcock corresponds to *rastripes* and not to *integra*. Some of the specimens of *integra* identified by authors referring to Alcock (1899) could belong to *rastripes*, as is further demonstrated for those of Tweedie (1950).

**Observations.**—The frontal lobes are "shallow bilobate" like indicated by Sakai (1939). The sinus of the supra-orbital border is well marked. The carapace is granular all over, the granules arranged in small transverse ripples at least on the postfrontal and lateral region. The small specimens under 10 are smooth. The dactyli of the pereopods 2-5 are "blade shaped and recurved" as described by Sakai (1939). On the largest male (277), the two chelipeds are clearly unequal, and with a different shape. On the major cheliped the two fingers are shorter, the palm is higher than on the minor; on the minor cheliped the palm is clearly longer than on the major. Sakai (1939) writes: "Chelipeds are subequal in size but usually unequal in the shape of the fingers . . . the fingers of one

cheliped are very often longer than those of the opposite cheliped; in a very young specimen, the movable finger is usually very much more incurved inward than in the adult."

On a smaller male (275) of 10x11 the two chelipeds also are clearly unequal and very like the large specimen; the female of the same series (275) is damaged and has only one cheliped which has short fingers but is comparatively less swollen and more acutely granular than on the male. Another small male (the largest of the material from the Mariel King Mem. Exp.) has the chelipeds which seem to agree with the characters of the young mentioned by Sakai (1939): the two fingers of the two chelipeds being "more incurved inward". On the large specimens the black pigment of the fixed finger extends to half the height of the palm on the distal area.

The male pleopod 1 seems to be nearly similar with those illustrated by Sakai (1934, text-fig. 64) and Buitendijk (1960, fig. 1a). However I hold some reserve on the identity of the present material with *integra*.

The species is recorded from Japan (De Haan, Balss, Sakai), China (Gordon), Hawaii (Rathbun), Gilbert Island (Balss) and Sulu Molucca Seas (present record). Miers (1884, p. 235) in recording specimens of *nitida* mentioned that in the British Museum, specimens from Philippines (Cuming collection) probably belongs to *integra*. It is, with *nitida* and *rugulosa*, the most recorded species of *Kraussia*. The specimen (WAM.271-70) from the S. of Cape Poivre is the first record of the species in Australian waters.

#### *Kraussia bongensis* nov. sp.

(Figs. 19, 20, 23J, 24)

Type specimen: Western Australian Museum.

Type locality: Tawitawi Bay, Sulu Archipelago.

**Material.**—Holotype (WAM.263-70A) male of cl:20, cb:23; Paratypes, WAM.263-70B, male of cl:15, cb:17; WAM.263-70C, male of cl:14, cb:15, Loc: about 9 miles 130° from Bongae Light, Tawitawi Bay, Sulu Arch., Coll: B. R. Wilson on "Pele", Date coll: 29/2/1964. Other specimens of the same loc: 2 males and 1 female, the largest of cl:9.5, cb:11.

**Diagnosis.**—(Holotype). Carapace dorsally convex with fine small granular transverse ripples all over. Front bilobate, anterior margin of lateral frontal lobes straight, no trace of antennal sulcus. Antero-lateral border with a feeble concavity behind external orbital angle and posteriorly a feeble notch. Two chelipeds unequal and differently shaped. Major cheliped with palm higher and longer than that of minor cheliped. Length of fixed finger clearly more than one-third of height of palm on major cheliped, and clearly less on minor cheliped. Outer surface of both chelipeds similarly covered with salient granular transverse ripples and ornamented on distal part with black colour of fixed finger extending near upper border of palm. Dactyli of pereopods 2-4 sickle-shaped with anterior border concave without granules save on a very short proximal flat-



tening; anterior border of pereopod 5 entirely granular. Male pleopod with apex forming a lamellar broadening lobe with round distal margin; some subdistal long acicular setae and some stout pre-apical spines.

*Observations.*—Only on the holotype is the black colour of the palm strongly marked. The male pleopod of the largest paratype has a larger number of subdistal setae and the apical lobe slightly differently shaped. On the smallest male the apical lobe is only developed as a straight small tongue not significantly broadening distally.

The male pleopod provides the most significant discrepancy between *bongensis* and *integra*. In addition, *bongensis* differs from *integra* by: (1) the frontal lobe with anterior margin straight instead of sinuous and median sinus closer.—(2) a marked small concavity immediately behind the extraorbital angle.—(3) a less subquadrate outline of the carapace border and its dorsal surface more convex.—(4) the fingers of both chelipeds which are more incurved with a wider gap.—(5) the black colour of the palm extending higher.

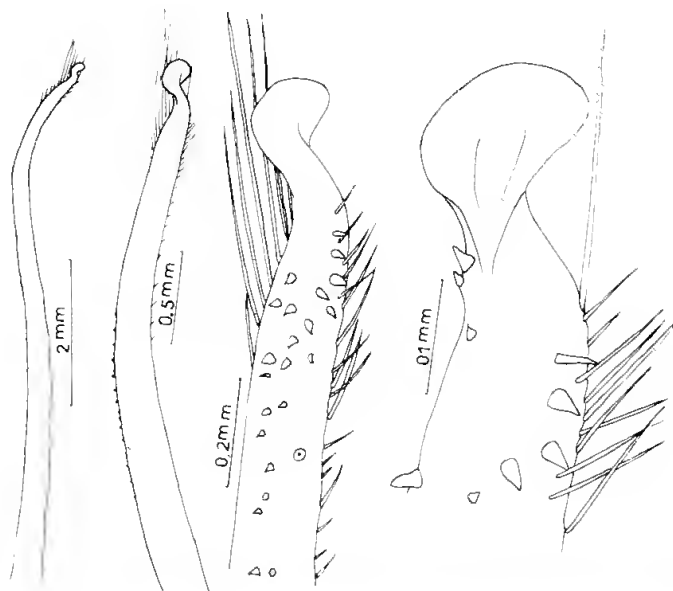


Figure 19.—Male pleopod 1 of *K. bongensis*, WAM 263-70 of cl:20, cb:23.

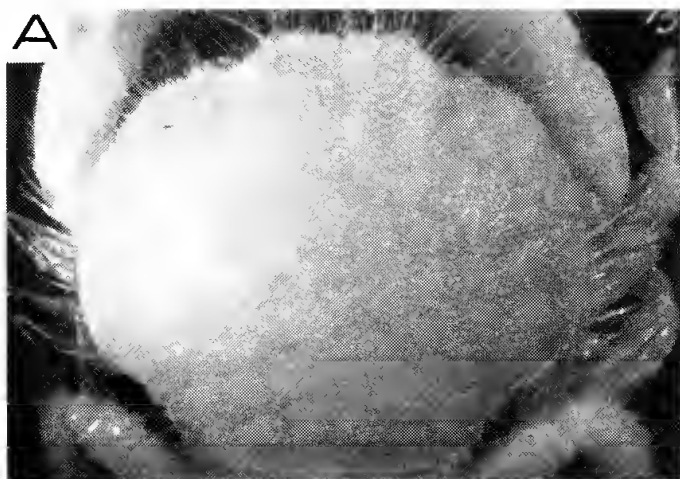


Figure 23.—*Kraussia bongensis*, WAM 263-70, male of cl:20, cb:23. A, dorsal view.—B, pereopods 4, 5.—C, right cheliped.—D, left cheliped.

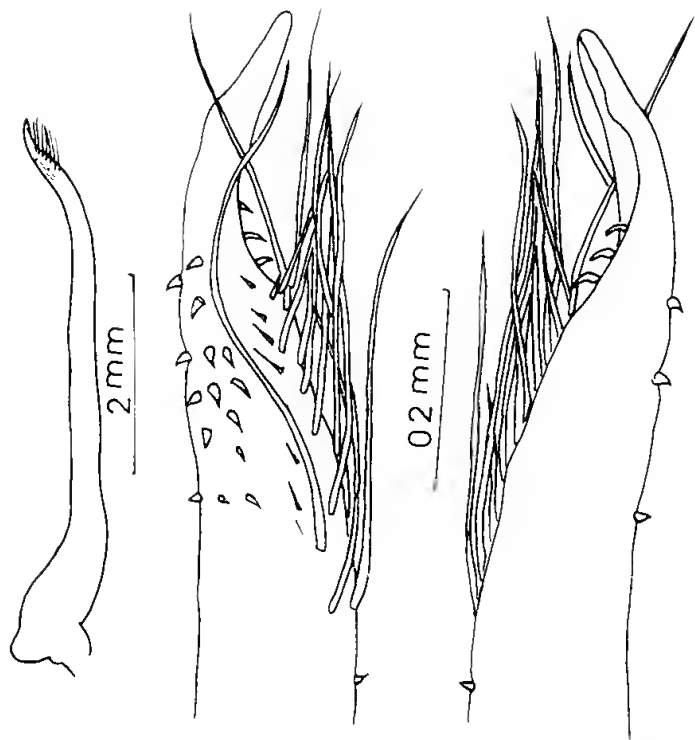


Figure 21.—Male pleopod 1 of *K. rastripes*, NMS.1969. 11.20.4 of cl:9, cb:10.

Measurements taken on the carapace of largest males of *integra* (1), *bongensis* (2) and *rastripes* (3) give the following ratios:

	1	2	3
carapace breadth/carapace length	1.13	1.14	1.14
frontal breadth/carapace length	0.33	0.33	0.44
frontal breadth/carapace breadth	0.29	0.29	0.38
fronto-orbital breadth/carapace breadth	0.54	0.50	0.58

This demonstrates that only *rastripes* has a front clearly broader than *bongensis* and *integra*. The comparison of the present ratio with those given before for the *aff. nitida-marquesa* group confirm that the specimen of *marquesa* from Puerto Galera has a carapace broader than any other.

#### *Kraussia rastripes* Muller 1887

(Figs. 21, 22, 23K)

*Kraussia rastripes*, Muller, 1887, p. 480, pl. 4, fig. 5.—Borradaile, 1900, p. 576.—Balss, 1938, p. 28, fig. 13.

*Kraussia integra*, Alcock, 1899, p. 97.—Tweedie, 1950, p. 108. Not *integra* (De Haan).

Type locality: Ceylon (Trincomale).

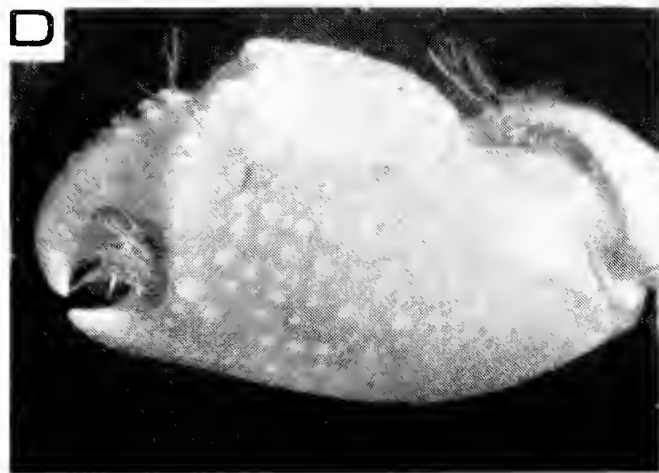
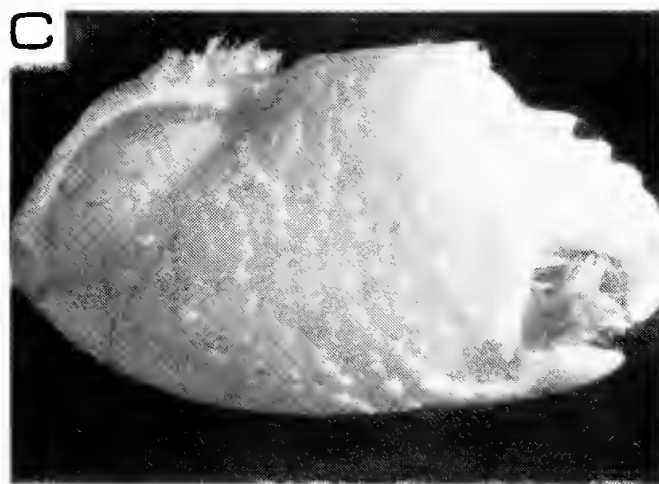
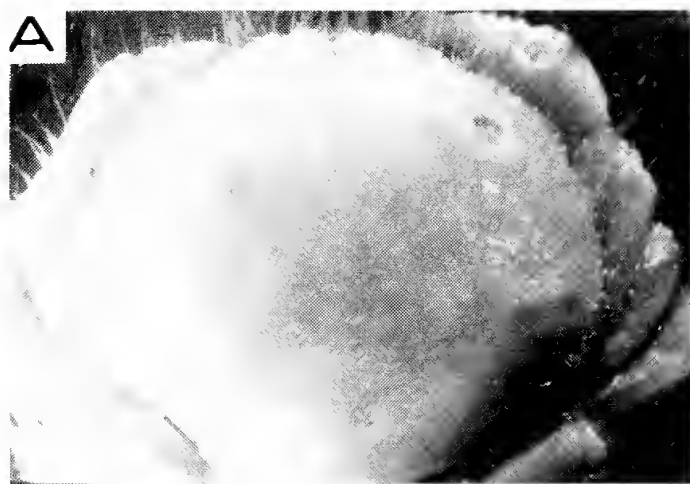


Figure 22.—*Kraussia rastripes*, NMS.1969 11.20.4. female of cl:10, cb:12.40. A, dorsal view.—B, pericopods 3, 4. 5.—C, right cheliped.—D, left cheliped.

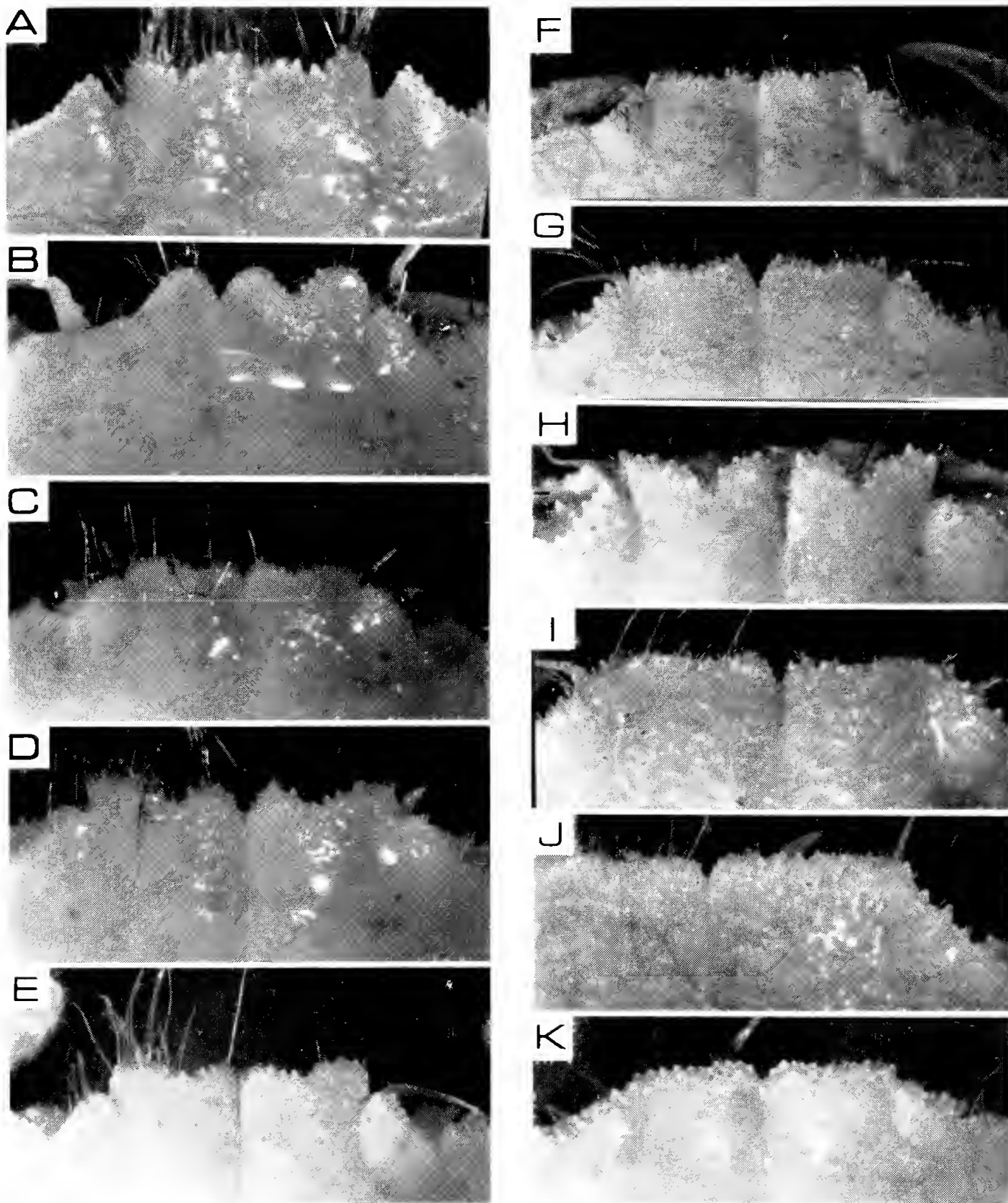


Figure 23.—Frontal border of *Kraussia*: A, *rugulosa*.—B, *quadriceps*.—C, *wilsoni*.—D, *pelsartensis*.—E, *roycei*.—F, *aff. nitida*.—G, H, *marquesa*.—I, *integra*.—J, *bongensis*.—K, *rastripes*. Save for H, male of cl:15.3, cb:18.6 of *marquesa*; all specimens are those illustrated in the previous photographs. All photographs with magnification approximately x 10.



*Material*.—NMS.1969.11.20.4, male of cl:9, cb:10; NMS.1969.10.10.4, female of cl:10.8, cb:12.40; NMS.1969.10.10.5, female a little smaller, Loc: Cocos Keeling, Coll. Gibson Hill 1941, Det: as *integra*? by Tweedie, 1950, p. 108.

*Remarks*.—Tweedie (1950) expressed reserve in his identification by placing a ? on the label of the jar; the reserve is not indicated on his paper. The specimen agrees accurately with the description of Alcock (1899) for *nitida* but clearly differs from *integra*. Tweedie (1950), referring for his identification as *integra* to Balss (1938), who does not give any illustration nor any comments on *integra*, was probably referring to the description of Alcock (1899).

Muller (1886) mentions the close relation between his species and *integra* but among the characters of *rastripes* he states that the pereopods 2-5 have on the anterior border of the propodi two or three rows and on that of the dactyli one row of acute tubercle-like saw-teeth (Sagezähne). In the description of *integra* by Alcock (1899) the dorsal surface of the dactyli of ambulatory legs "abundantly and elegantly denticulate" correspond to *rastripes* and not to *integra*, which according to Sakai (1939) has those dactyli "blade shaped and recurved".

The name *rastripes* given to a single male of 13 x 15 has been correctly used by Borradaile (1900) for a female from Rotuma, and by Balss (1938), who examined 4 females and 1 male from the Hamburg Museum and one female from the Berlin Museum but gave the size of only one female of 12 x 14. I correct as *rastripes* the identifications of the *integra* specimens of Alcock (1899) and Tweedie (1950).

*Observations*.—The species can be identified at first view by its subcircular carapace ("Panzer subcycloid", Muller) and strongly denticulate ambulatory legs. The material of Tweedie (1950) was examined and found in full agreement with the descriptions and illustrations of Muller (1886) and Balss (1938). *K. rastripes* differs from *integra* and *bongensis* by: (1) the dorsal surface of the carapace more convex and nearly smooth.—(2) the frontal border less salient beyond the orbit and forming a hemispherical curve with the anterolateral border, which are without indication of any notch.—(3) the absence of sinus on the upper orbital border.—(4) both chelipeds equal and identically shaped; the length and height of the palm, the length and shape of the fingers are the same in the two chelipeds.—(5) the palm of the cheliped higher with granules larger but less numerous and more separated; similarly the granules in the dactyli are larger and more separated.—(6) the anterior border of the dactyli of the pereopod 2-5 nearly straight, all along flattened with on each side of the flattening a row of acute teeth.—(7) the male pleopod.

As indicated before in the observations on *bongensis*, also the front of *rastripes* is broader than on these two species.

*K. rastripes* is recorded from Ceylon (Muller), Rotuma (Borradaile), Gilbert Island, Pulau Island, Carolines Island, New Guinea (Balss), Andamans (Alcock), Cocos Keeling Island (Tweedie).

#### Remarks on the ecology, the ethology and the relationship of *Kraussia*

I myself have never seen a living specimen of *Kraussia*; the present remarks only refer for ecology to the data of the present collection and some few authors; for the ethology to personal observations made on other groups of Brachyura.

The species of *Kraussia* live on bottom of coarse sand around the rocky and coral area extending from the shores to the depth of 100m. They are digging crabs like the other Corystidea, the Gymnopleura, some Oxystomata, some Xanthidae, Goneplacidae and Pinnotheridae. Observations on the behaviour of these forms and on the ecological condition of their habitat (nature of the bottom, composition of the sand or mud by granulometry) will help to understand the function of their morphological structures.

The vaulted carapace of *Kraussia* with the pereopods (when folded) partly fitted below the margins is somewhat similar to that of *Calappa* for example. It suggests that, like *Calappa* when it has dug, *Kraussia* hides its body under the sand in a oblique position, its anterior part at the level of the surface of the sand and the posterior part a little lower.

During the examination of the present material in order to find morphological structure which could provide characters for specific differentiation, I noticed on the ventral side of the posterior half of the lateral border of the carapace of *integra* and *bongensis* a shallow, elongate and smooth depression. Situated between the pterygostomian line and the edge of the border, this structure reminds me of a similar but more developed one which I recently observed on *Guinotellus* Serene 1971, a new genus of Xanthidae. This genus is briefly described from type material consisting of only one carapace without pereopod which was then the only available material; its relationship to *Hypocolpus* and *Euxanthus* is briefly mentioned by Serene (1971).

The comparison of *Kraussia* (mainly *integra*) with large specimens of *Guinotellus* in good condition presently in hand demonstrates several close relationships between the two genera, and suggest that *Guinotellus* could be a morphological link between the Euxanthoidea (*Hypocolpus*-*Euxanthus*) and the Thiidae (*Kraussia*), two groups with probably the same ethology.

The relationship between *Kraussia*, *Guinotellus* and *Euxanthus* are supported by several morphological structures, such as the lateral border of the carapace vaulted with the ambulatory legs when folded at least partly concealed; the chelipeds strongly fitted against the pterygostomian region; the third maxilliped, sternum and abdomen narrow; and the male pleopod 1 elongate and slim. But *Euxanthus* and *Guinotellus* clearly differ from *Kraussia* by the orbito-antennal region and the presence at the anterior limit of the buccal cavern of a small but clearly marked margin, which does not exist on *Kraussia*.

Other common characters like the occasional presence on the carapace of small, flattened (squamiform) granules arranged in transverse

lines (like ripples) seems to be related to the ecology and ethology of the forms. It is perhaps also the case for the indication on *Kraussia integra* and *bongensis* of a shallow ventral cavity under the margin of the posterior part of the lateral border, which on *Guinotellus* are so well developed in the anterior part.

The function of these cavities is probably related to the water current running in the vault organized under the lateral margin of the carapace. Similarly, the notches of the lateral margins of *Kraussia* could be related to the passage (output or input) of such a water current. Without speculating further, I summarize my observations by bringing together the illustrations (Fig. 24) of the ventral side of the lateral border of *Kraussia bongensis* and of *Guinotellus melvillensis* Serene 1971.

### Acknowledgements

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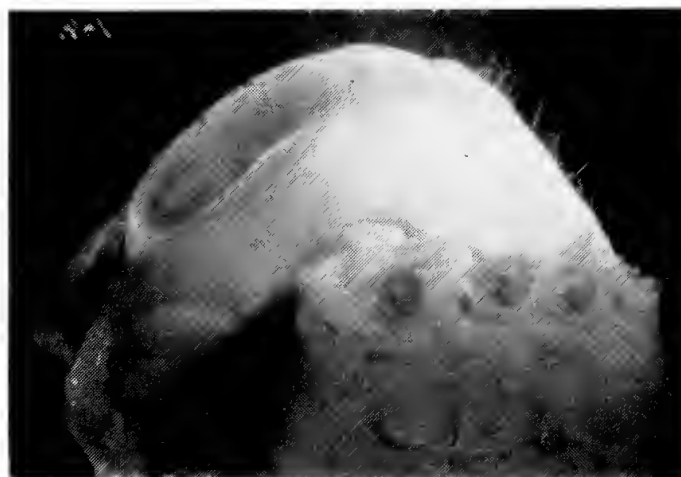
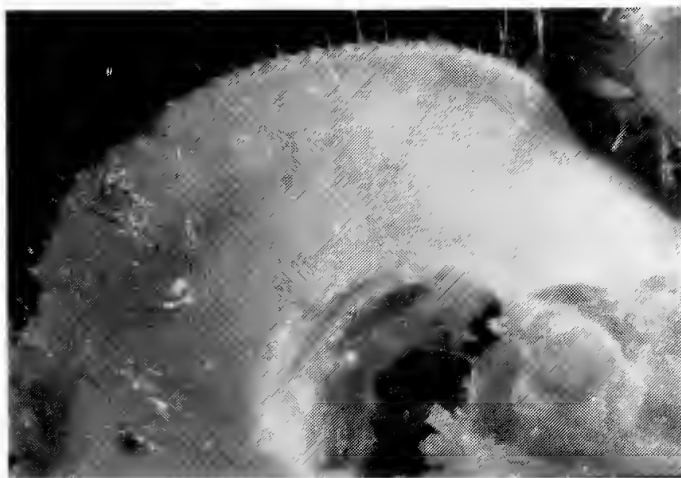


Figure 24.—Above, *Kraussia bongensis*, ventral side of the lateral border of carapace. Below, *Guinotellus melvillensis*, ventral side of the lateral border of carapace with cavity of the subhepatal region.

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